SCIENCE

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CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE FIFTIETH ANNIVERSARY OF THE AMERICAN ASSOCIATION.

THE American Association for the Advancement of Science celebrated the fiftieth anniversary of its foundation at Boston from the 20th to the 27th of August. The meeting, as all knew would be the case, was eminently successful, both in regard to the scientific work accomplished and in the occasions for social intercourse and enjoyment so liberally provided. As stated in the report of the new Permanent Secretary, Dr. L. O. Howard, at the closing session, the meeting was in many respects the most successful in the history of the organization. In point of numbers the attendance made it the fourth meeting in the history of the Association. Two of the meetings which have exceeded it in attendance have been held in conjunction with the British Association for the Advancement of Science, and the third was held in Boston; so that Boston has been excelled only by Boston. The scientific and other advantages of Boston, and the fact that the meeting celebrated the fiftieth anniversary of the founding of the Association, attracted members in large numbers. The total registration was 903, and almost every State in the Union was represented. The State which had the largest representation was naturally Massachusetts, with a total of 231; New York came second, with 158, and the District of Columbia third, with 96.

The other States were represented as follows: Pennsylvania by 55; Ohio by 53; Connecticut, 29; New Hampshire, 23; Michigan, 23; New Jersey, 20; Maryland, 19; Wisconsin, 18; Missouri, 17; Illinois, 15; Rhode Island, 14; Indiana, 12; Maine, 10; Virginia, 10; Iowa, 10; Vermont, 7; Minnesota, 7; North Carolina, 6; Florida, 6; Kansas, 5; Mississippi, 5; Kentucky, 5; West Virginia, 4; Georgia, 4; Louisiana, 3; Tennessee, 3; Texas, 3; Colorado, 3; South Carolina, 2; Nebraska, 2; and Montana, North Dakota and California, 1 each.

The term American has always been held by the Association to include not only citizens of the United States, but of other American countries, and members from Canada have always been present at the meetings. At this session there were present 16 members from British North America. There were representatives from other countries in attendance. The Republic of France sent an official representative, who, with his wife, appears upon the registration list of the meeting. Moreover, three persons have registered from Great Britain; one from New South Wales; one from Brazil, and one from Japan.

Not alone in point of the numbers in attendance was the meeting remarkably successful. More papers than usual were read before the different sections, and it is unnecessary to make the statement that the character of these papers as a whole was of the highest order. Considering that during the week an entire day was spent at Salem at which no papers were read, and that another day was spent at Cambridge during which but few papers were read, and that the first day, Monday, was entirely occupied by the general session and the delivery of the addresses of the Vice-Presidents, it is remarkable that the Association should have completed the reading and discussion of so many different papers. In all 443 papers were considered during the week. Of these 39 were presented to Section A; 51 to Section B; 90 to Section C; 20 to Section D; 54 to Section E; 35 to Section F; 56 to Section G; 10 to the Botanists' Club; 55 to Section H; 33 to Section I.

The success of the Boston meeting was further very marked in the attendance of so many of the older and more prominent men of the United States. No less than nine past Presidents of the Association took part in the discussions of the week, and in this fact, no less than in the greatly increased attendance over that of the last meeting, is to be seen most encouraging signs of the future of the Association.

The first general session of the Association was called to order by the retiring President, Professor Wolcott Gibbs, at 10 o'clock on the morning of August 22d. Addresses of welcome were made by His Excellency, Roger Wolcott, Governor of Massachusetts; His Honor, Josiah Quincy, Mayor of Boston; and President James M. Crafts, of the Massachusetts Institute of Technology, to which a reply was made by President Putnam.

The address of Governor Wolcott, as reported in the *Transcript*, was in part as follows: It is with far more than ordinary pleasure that, on behalf of the Commonwealth, I extend a most cordial greeting to those who are present here to-day. The American Association for the Advancement of Science on this, its fiftieth anniversary, has done well to return to the soil of the Commonwealth which was the place of its birth and which gave to it its charter. I welcome you all—those who come from the many cities of our country and those who come from foreign lands. The Commonwealth is honored by your presence. As seekers after truth, you have devoted your lives to following the footsteps of science, whether her majestic way is across conti-

nents, following the pathway of stars, or whether she delights to follow the minutest particles revealed by microscopic research.

Governor Wolcott then described at length in an eloquent and scholarly manner the many benefits coming to the world by the researches of men of science, and, continuing, compared them to the men who have erected lighthouses on the coast, guiding and directing the course of those who will come after them. He spoke of the infinite possibilities of science, and said that, in spite of the great advances that have been made, little is known to-day of the mysteries of nature, so elusive is its touch.

It is for you, he said, little by little, as the years and centuries go on, with faithful and painstaking search, to learn a little more of that great ocean of truth and to launch your barks a little farther on the sea of science, and to know more about the stars, the plants, the pebbles and the shells. The truth is that science is still sweeping beyond you and is beckoning you to follow her. Science would be less worthy of our regard if its benefits should be limited to any class, but it is open to all.

It is as men of science that the Commonwealth welcomes you to-day. May you bear away from this meeting pleasant memories of the State, rich in the valor and achievements of her sons. And may you leave behind you that inspiration which is fostered and cherished by men who are brought together to compare notes and clasp hands and carry back memories of this meeting. The Commonwealth greets you and expresses to you her recognition, and bids you welcome to the old Bay State.

Mayor Quincy, being introduced, spoke as follows: We are grateful to you for giving us an opportunity of seeing you here, that we may listen to your deliberations and exercises, and for having the privilege of entertaining you in some measure. I may say in truth that there is no other city in this country which would appreciate more highly the privilege of having this anniversary meeting held within its borders than the city of Boston. I think I may claim with truth that in no city is science held in higher esteem, in no city is the great work of science and the widespread beneficence of its results more recognized than in the city of Boston. There is no organization to which we would more gladly open our doors than to your American Association for the Advancement of Science. Your work has a very direct relation to the work in which the people of the city of Boston are engaged, in their corporate capacity, and the work which their municipal government is trying to prepare for them. As I regard it, the work of good municipal government is the task of securing the practical application of the principles of science to the great fund of knowledge which has been won for us by science. I am continually impressed in my practical relation to the work of this great city with the vital relation which science bears to that work. More efficient government is to be sought along the lines of affairs which fall within the scope of our municipal government, and this is to be won for us by the investigators who have increased their knowledge of science within the last fifty years.

I trust and believe that this interesting occasion may do something for us as well as something for the American Association for the Advancement of Science, and I hope that among other benefits it may give to our citizens as a whole a greater appreciation of what science is and of what science does; and not only of what science does in the abstract or in the way of theoretical investigation, but demonstrate the value of science as the handmaid of civilization which enlarges the views of mankind and lifts society up to the highest plane of thought. If the first result is economy in

its relation to humanity; if its first effect is to enlarge our minds and give us a wider power of interpretation of nature, to harness more effectually the forces of the great mother, and to save labor, it has no less surely its social and its intellectual side. First is to be considered the economical possibilities, which mean easier living with infinite improvements in the art of living, and after it comes the advancement of all humanity and the more complete progress which must accompany social uplifting. We are endeavoring in a partial and incomplete way to apply some of the principles of science to the practical benefits of the one-half million people within the limits of this municipality. I am proud to say that we give a high place in everyday work to men of science who are giving technical application to the principles which have come to light through the investigations of abstract science. Work in the future will demand a fuller employment of men of science. I am proud to say that we are commanding the interest and the services and the hearty cooperation, without price and without regard, of men who are endeavoring to give in some measure a practical social science, and, while this may be a far less exact science that many others, I firmly believe that there is a social science and a political science, and that the domains which come within its knowledge are constantly widening, both as regards the body social and its evolution and the body politic and how to secure its best application. I heartily congratulate the American Association and welcome it back, after fifty years, to the scene of its birth, and extend thanks and welcome, on behalf of the city of Boston, to each and every one of its members, in view of this meeting here and the work which the Association is yet to do in the first half of the century to come.

President Crafts, of the Massachusetts Institute of Technology, followed Mayor Quincy, and made a most interesting address, which is printed in full below.

President Putnam, on being introduced by the retiring President was heartily cheered, all recognizing that his services as Permanent Secretary for twenty-five years had been the chief factor in the great growth and success of the Association, while his own contributions to science had given him a double claim to the highest office in the gift of the Association at this anniversary meeting. President Putnam made an address which it is hoped may be subsequently published in this JOURNAL.

M. Charnay, the official delegate from the French government, was introduced and spoke briefly in French. A message was also read from the Russian Geological Committee of St. Petersburg sending congratulations and good wishes. After listening to announcements of the Local Committee the session adjourned.

In the afternoon the Vice-Presidents gave their addresses before the different Sections as follows:

Section A. Mathematics and Astronomy: Development of Astronomical Photography; Vice-President Barnard.

Section B. Physics: On the Perception of Light and Color; Vice-President Whitman.

Section C. Chemistry: The Electric Current in Organic Chemistry; Vice-President Smith.

Section E. Geology and Geography: Glacial Geology in America; Vice-President Fairchild.

Section F. Zoology: A Half-century of Evolution, with Special Reference to the Effects of Geological Changes on Animal Life; Vice-President Packard.

Section G. Botany: The Conception of Species as Affected by Recent Investigations on Fungi; Vice-President Farlow.

Section H. Anthropology: The Advance of Psychology; Vice-President Cattell.

Section I. Economic Science and Statistics: The Historic Method in Economics; Vice-President Blue.

Vice-President Cooley, of Section D, Mechanical Science and Engineering, having been detailed to active service in the navy

was unable to be present, but the Section was addressed by Professor R. H. Richards, his subject being 'Ore-Dressing.' The addresses of the Vice-Presidents will be published in full in SCIENCE.

In the evening the retiring President gave the highly important though somewhat technical address 'On Some Points in Theoretical Chemistry,' printed in the last number of this JOURNAL.

The work of the Sections was chiefly confined to the morning, afternoon and evening of Tuesday and Thursday, though some of the Sections held sessions on Friday and Saturday. The scientific papers presented will be adequately reported in subsequent issues.

Wednesday was devoted to an excursion to Salem and neighboring places of scientific and historic interest. By invitation of the President and Fellows of Harvard College, the members of the Association were guests of Harvard University on Friday. The scientific museums and laboratories were visited under the guidance of the heads of the departments, and in the evening President Eliot made a most admirable address, a report of which is given below. Among the other entertainments provided for members were receptions by the trustees of the Museum of Fine Arts, and the officers of the public library, by Governor Wolcott, Mrs. W. B. Rogers and Mrs. J. C. Phillips. Mayor Quincy entertained the principal officers of the Association and several foreign guests at dinner on Tuesday evening. There were also private dinners and receptions given to various members. Many interesting excursions were arranged by the Appalachian Mountain Club, including an extended trip to the White Mountains, following the meeting.

During the meeting the Council held frequent sessions. Several alterations in the Constitution, which will be acted on at the next meeting, were recommended. A number of fellows were elected, including several leading men of science. Grants of $50 each were made to the Committee on Standards of Measurement for work being carried on by Professor H. S. Carhart, and to the Committee on the Ethnology of the White Race in America, for instruments to be constructed by Professor J. McK. Cattell. Other applications for grants were laid on the table on the ground that they did not fill the conditions of a resolution passed by the Council which was as follows:

Resolved, That grants be awarded under the following conditions:

(1) That a formal request be received for such grant.

(2) That a grant be awarded for a specific investigation only.

(3) That a report be submitted to the Association describing the results of such investigation.

The Council authorized Section H (Anthropology) to hold a winter meeting in December, 1898. This will be held at Columbia University, New York, in connection with the meeting of the American Society of Naturalists and affiliated societies, and at the same time a meeting of the Council of the Association will be held.

The concluding general session on Saturday morning was chiefly devoted to the customary addresses of thanks, which this year were presented with unusual cordiality. Dr. McGee offered the resolutions, and short addresses were made by M. Charnay, Dr. Brinton, Dr. Hovey, Professor Sedgwick, Professor Tyler, the Rev. Dr. E. E. Hale and President Putnam. A report was made to the Association of the work of the Council, including the announcement that Columbus, Ohio, had been chosen as the next place of meeting, and that the following officers had been elected for the ensuing year:

President: Edward Orton, President of Ohio State University.

General Secretary: F. Bedell.

Secretary of the Council: Charles Baskerville.

Treasurer: R. S. Woodward.
Vice-Presidents:
Section A. Alexander MacFarlane.
Section B. Elihu Thomson.
Section C. F. P. Venable.
Section D. Storm Bull.
Section E. J. F. Whiteaves.
Section F. Simon H. Gage.
Section G. Charles R. Barnes.
Section H. Thomas Wilson.
Section I. Marcus Benjamin.
Secretaries of Sections:
Section A. John F. Hayford.
Section B. William Hallock.
Section C. H. A. Weber.
Section D. James M. Porter.
Section E. Arthur Hollick.
Section F. Frederick W. True.
Section G. W. A. Hellerman.
Section H. George A. Dorsey.
Section I. Calvin M. Woodward.

JAMES MCMAHON,
General Secretary.

A GREETING TO THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.*

To the greetings which have been so cordially offered to you in behalf of the State and of the City it is my privilege to add a few words of welcome from the Institute, which is honored by your visit to-day.

You have not often favored us with your company, for you waited until the 29th year of the foundation of the Association before you held your first Boston meeting. Now twenty-one more years have elapsed before you visit us again, and we are pleased that it should be for the purpose of holding your semi-centennial anniversary in this city.

If your visits, like those of angels, are rare they are all the more highly prized, and many of us feel that we must make the most of this one, because we may not, in the course of nature, hope to live to see you with us again, if your orbit is fixed by the intervals of your past appearances. While saying that you waited twenty-nine years before making your first call upon us, it should be added that long ago, in 1849, the second meeting of the Association was held in Cambridge, and that the Bostonians had the advantage of participating in that meeting in the same way that now our good neighbors of Cambridge and of other near places join in welcoming you to this one.

At the date of the Cambridge meeting Harvard College was 213 years old, and the institutions of Boston and of the neighborhood which now have the honor of greeting you were unborn and unthought of. Since that time Tufts College, Boston College, the Massachusetts Institute of Technology, Boston University and Wellesley, naming them in the order of their foundation, have grown up like young plants, and, notwithstanding the rapid increase of Harvard University, they surpass it at present in the number of their students. The total adds up to nearly 8,000 students and more than 800 teachers, about the same number as at the University of Paris.

It would be a poor greeting to deluge you with statistics, but I trust you will pardon these few, which are meant to show that since you have visited us we have been diligently occupied in preparing a fitting audience to meet your second, or rather your third coming, for the teachers and students in these colleges have come in larger part from New England, and particularly from this neighborhood, and, their education finished, they have remained in their New England homes, and whatever has clung to them of their college life is potent in shaping the modes of thought of their community. This center of education, then, is one of the largest in the world, and it is eager to give

*By President J. M. Crafts, Massachusetts Institute of Technology, at the opening session, August 22, 1898.

you the kind of reception which you will most prize, those tokens of sympathy, of respect and of appreciation which spring from knowledge; for educated men know that men of science are discovering those truths which form the newest and truest part of their education. Sometimes the surroundings of a scientific man impress upon him a sense of isolation. He is asked: What good are such things? when he has discovered a new formula or a new exhibition of energy or a new substance, or has dissected the nervous system of a worm. He has no leisure to answer such questions, but he works on contented if he is not disturbed, and expects little applause unless he turns out a salable product. Let him, however, come in contact with those whom modern methods have trained to some knowledge of science, and he immediately finds ready support and sympathy and some share of the enthusiasm which he feels himself.

It is now as much a part of a good education to know something of scientific facts as it is to know the causes which led to the fall of the Roman Empire. I do not mean that we make scientific men of the great body of our students any more than the study of history transforms scholars to statesmen. When freshmen enter our laboratories we have small hope that they will make original discoveries, but we are well content if, while fitting themselves for some practical occupations, they learn the great lesson that new truths can only be found out by observation and experiment, and if they learn habits of honesty of thought by dealings with nature, which never lies. These men form the great public who have come forward so willingly and so generously to lend a helping hand to science. Perhaps in their college life their unskilful experiments have taught them to admire the skill which has made yours successful, their attempts at observation have given them some idea of the acuteness of powers which can be acquired by long years of faithful training.

Those who have pleasure in scientific occupations are ready sympathizers, and know something of the joy which a discovery brings with it even if there is no money in it. As to those among us—and there are many who have devoted their lives to scientific work—I have no need to assure you of their hearty welcome, of their desire to meet you in this congress, and to listen to the news of your latest achievements and perhaps to tell you some of theirs. Your connection with our colleges is very direct, for many of the members of this Association have taken a leading part in this work of education, and in this neighborhood we have been fortunate in our teachers. Scholars who have walked the fields with Gray and Agassiz, who have learnt their mathematics from Peirce, their anatomy from Wyman, or their chemistry from your retiring president, might look the world over without finding leaders better fitted to guide them to the innermost chambers of scientific knowledge. In this place it is most fitting to mention the chairman of the first meeting of this Association, William B. Rogers, who was a born educator. He loved science for its own sake, and he had a patriotic desire to see his country call upon science to aid in its material progress. His efforts began so far back as 1828, when he thought it useful to lecture to the American people in Baltimore upon the advantages which he hoped would be derived from building railroads in this country. He demonstrated the known principles of railroad building, and showed that traction upon smooth iron rails was possible. Afterwards, when he came to Boston, his thoughts were full of a project for interesting the community in providing means for the education of men to direct our growing industries. This Institute was

founded, and this building erected because Rogers knew how to make science popular; his contagious enthusiasm inspired many co-workers who have not yet ceased in their task. With great simplicity of character he united an ardent imagination which gave a singular fascination to his public exposition of scientific truths. You perhaps know him best through his earliest endeavors for the foundation of the Geological Society, and you know that, later, just 50 years ago, he contributed with all his heart to the formation of this Association. His later years were devoted to the Institute which he built up, and which now, largely grown from small beginnings, has the honor of welcoming you this day; and it was on this stage that he fell, an unfinished sentence on his lips, giving his life to the cause which overtaxed his strength.

The memories which attach themselves to this place have led me to speak thus at length on this fiftieth anniversary of one who was a principal founder of one Association, and yet other memories crowd into this hall.

The Lowell lectures have been held here for many years, and to your Association belong many of the eminent men who have stood upon this platform, and who have done much to make the Boston public no stranger to scientific assemblies. Some sixty-five years ago the strongest interest in lectures was excited in New England by the qualities of certain lecturers. The eloquence of Edward Everett, the character, the new doctrines and the fascinating delivery of Emerson made men feel that book knowledge was of little worth, and that the living voice was the true means of communication with man. It seems like the difference between reading testimony or hearing a witness. Under these impressions John Lowell, Jr., a young man of 34, after the misfortune of losing wife and children, made a will by which he devoted half his fortune to founding courses of free lectures. His death happened soon after in a foreign land, and the fund came into the hands of his cousin, John Amory Lowell, who made its care and administration the chief occupation of his life and has been succeeded in the charge by his son. In these hands the Lowell lectures have grown to be the largest enterprise of the kind in the world. The fund suffices to maintain 500–600 free lectures yearly, and to offer inducements to the most distinguished men in all English-speaking lands to come to speak to Boston audiences. We owe to this enterprise the visit of many a man of science to this country, and, in one notable case, a permanent settlement. You all know that Louis Agassiz was called to the United States to deliver a course of Lowell lectures, and that he became as good a citizen as he was a savant.

As you will see by the guide-book prepared for the use of the Association, great libraries and museums have kept pace with the intellectual and material growth of the community, and the needs of science are represented in them as well as those of art and literature. Our museums depend more than other institutions upon popular appreciation for their support, and calls upon public liberality must be seconded by a presentation in some striking and evident way of the aims and scope of the work which the collections illustrate. I cannot help thinking that your presence and your discussions, and the effort which you make to come each year, often from great distances, contribute notably to keep the cause of science before us, and that you aid in its task each community you visit.

As you watch the motions of the stars, or make experiments in laboratories, or observations in the fields, or build bridges, as you seek to cure disease and alleviate pain, or reduce the actions of mankind to fixed laws, you doubtless have sometimes in view

your summer meeting, and look forward to talking over with each other your discoveries and your difficulties, and as you are willing to do this in public, the whole community as your place of meeting comes to a better knowledge of the beautiful, earnest, skilful effort which makes up the life of a man of science. It is not a congress to adjust conflicting interests or for displays of oratory which lead to no conclusions. We get to know the man himself, and I think he would be even more popular than he is at present if we could invent some suitable name for him. Scientist is a most ill-sounding word. The French term savant —a knowing one—might provoke a smile, when contrasted with the simplicity of character of many men of science, but perhaps after all this is your best title to fame. Your discussions do not often degenerate into disputes, because for the first time in the history of the world methods of work have been found so sure that the results can be accepted almost without discussion. Even the geologists come to an eventual agreement about their theories, and the account which Bret Harte has given about their meetings must not be taken too literally. You are good witnesses and generally agree upon your facts, and when facts lead to differences of interpretation the single-minded desire to reach the truth brings you into accord at last.

We have good reason for welcoming you among us, and although you do not come as missionaries we shall find ourselves the better for your coming.

DESTRUCTIVE AND CONSTRUCTIVE ENERGIES OF OUR GOVERNMENT COMPARED.*

WE have been witnessing during the past five months an extraordinary exhibition of energy on the part of the government of the United States in making sudden preparation for the war with Spain and in prosecuting that war to a successful issue. As men of science, or teachers or promoters of science, we have a special interest in the lessons of the war, because the instruments and means used in modern warfare are comparatively recent results of scientific investigation and of science applied in the useful arts. Moreover, the serviceable soldier or sailor is himself a result, not only of moral inheritance and instruction, but of training in the scientific processes of exact observation, sure inference and accurate manipulation. It is not the linguistic side of school training which makes the effective soldier or sailor; it is the scientific side. His vocabulary may be limited, though expressive, and his grammar false; but his eye must be true, his judgment sound and prompt, and his hand capable of using instruments of precision. The first-relief package, which every soldier carries, is crammed with surgical knowledge which the world waited for till the last quarter of the nineteenth century. Physiological science has really arrived at valuable conclusions with regard to the soldier's diet—the indispensable foundation of his effectiveness. Financial science is also a contributor of prime importance, since success in war depends more and more on the command of money and credit. To this war with Spain we owe the most effective revenue bill, or rather the only comprehensive revenue bill, the country has had within a whole generation.

It cannot be doubted, then, that the energy put forth by our government for the immediate purpose of capturing or destroying Spanish vessels, forts, towns and war material, and incidentally killing, wounding and starving Spaniards has been a great exhibition of power in applied science, and as such must commend itself especially to

* Abstract of an address given by President Eliot, of Harvard University, before the American Association for the Advancement of Science, in Saunders Theater, on August 26, 1898.

the attention of this Association. I hear already a protest against the thought that men of science can have any special interest in war—war, the supreme savagery, the legalization of robbery and murder, the assemblage of all cruelties, crimes and horrors set up as an arbiter of international justice. But the man of science has another view of war. He regards it as the worst survival of savage life, still occasionally unavoidable because of other survivals of the savage state, such as superstition, passion uncontrolled, and lust of wealth and power. He recognizes the fact that war makes a temporary and local hell on earth, and that all its characteristic activities are destructive; whereas all the normal activities of a free government should be constructive, and intended to promote the good of its citizens and general civilization; but he does not accept Sumner's dictum in his oration of 1845 on the 'True Grandeur of Nations'—"there can be no war that is not dishonorable." He recognizes that occasional war, and therefore constant preparedness for war, are still necessary to national security, just as police, courts, prisons and scaffolds are still indispensable to social order and individual freedom in the most civilized and peaceful States. Moreover, the man of science perceives that, while the immediately destructive objects in war are savage and barbarous, the instrumentalities and forces used in modern warfare are closely akin to the great constructive agencies and forces in human society. The applications of Bessemer steel in war are not its primary uses; its peaceful constructive applications give it its primary value. The application of compressed air for the transmission of power was not invented for the dynamite gun, but for tunnelling and mining. No nation can now succeed in war which has not developed in peace a great variety of mechanical, chemical and biological arts. Now, the normal activities of these arts must and do tend to advance human civilization. Their application to the destructive cruelties of warfare is abnormal. Yet, inasmuch as they are applied in war with a prodigious energy and intensity, it may well be that the acute horrors of even the shortest war may have a lesson for the long normal periods of peace.

Men of science, so far as I have observed, do not consider the martial virtues—courage, endurance, loyalty and the willingness to subordinate self-interest to the interest of clan, tribe or nation—to be the supreme and ultimate objects towards which the human race must struggle on. They regard these virtues as the elementary, fundamental, preliminary virtues, which can be cultivated in man's savage state, and so become the stepping-stones of his moral advance; but they know, on the demonstrative evidence of both history and natural history, that these virtues may co-exist with cruelty, rapacity and lust, and an almost complete indifference to both truth and justice. Civilization, in their eyes, means the adding of justice, truth and gentleness to the martial virtues, an addition which does not necessarily involve any countervailing subtraction. Truly, it is not war which prepares men for worthy and successful lives in times of peace. On the contrary, it is worthy life in time of peace on the part of individual men, or a nation of men, which prepares for success in war. Do we not all believe that the normal activities of peace under free institutions are the best possible, though not the only necessary, preparation for inevitable war, and that such normal activities never need to be, and never can be, purified or uplifted by avoidable war? Nevertheless, we may believe that some lessons for times of peace can be drawn from the prodigiously stimulated activity of the government and the sacrifices of the people in time of war.

The first important inference which may

be drawn from the experience of our government and people during the past five months is anthropological—it is the permanence of the martial virtues and their commonness. In any vigorous race these virtues may fairly be called inextinguishable. Civilized society is always maintaining a perilous conflict against natural forces, which ordinarily serve man's purposes, but sometimes try to overwhelm him. Fire, the greatest of man's inventions and his humblest servant, suddenly breaks out into destructive fury; wind ordinarily fills his sails, turns his mills and refreshes the atmosphere of his cities; but now and then in spots sweeps from the surface of the earth and sea all man's works—crops, buildings, vehicles and vessels. The mineral oil which every night lights so brilliantly the humblest homes in every clime occasionally kills the ignorant or careless user or sets a huge city in flames. Any single-minded worm or insect will be too much for man, unless man knows how to set some other creature of one idea at destroying the first invader. How small is the range of the thermometer within which men can live with comfort or even safety! A change of a few degrees below or above the normal range sets him fighting for his life. This conflict with external nature is the great school of mankind in courage, persistence, patience and forethought, and mankind never needs any other. It is, then, the regular pursuits and habits of a nation in times of peace which prepare it for success in war, and not the virtues bred in war which enable it to endure peace.

The second lesson to be drawn from the recent experience of the nation in war is the immense value of long prepared, highly-trained public service. The instant efficiency of our navy is a striking demonstration of this principle, which, of course, needs no enforcement before men devoted to science, but does need to be brought home to the great body of our people. The preparedness of our regular army for immediate service, and the comparative unreadiness of the militia, even in those States which have paid most attention to volunteer military organization, enforce the same lesson. Would that the plain teaching of this short war in this regard might sink into the minds of our people, and convince them of the immense advantages they would derive from a highly-trained, permanent, civil service in every branch of the public administration.

Another lesson of these pregnant months relates to a principle which underlies our form of government, but is often seen but dimly by portions of our people. I refer to the principle that the government of the United States should do nothing which any other visible agency—State, city, town, corporation or private individual—can do as well. This seems a strange principle to be enforced by the action of our government in time of war, since the government has a monopoly of this hideous activity; but this war has brought out in a very striking way the fact that, when it comes to the pinch, the source of victory is in the personal initiative of each individual commander and private soldier or sailor. In warfare, as in industries, the automaton counts for less and less, and the thinking, resourceful individual for more and more. The automaton is the natural result of despotic institutions, civil and religious; the resourceful, initiating individual is the natural product of free institutions, under which the citizens are as little restricted as possible in the development and training each of his own will-power and capacities. To secure this fundamental advantage of free institutions, as many fields of activity as possible must be left open to the individual and to voluntary associations of of individuals. The maxim 'in time of peace prepare for war' means, therefore,

vastly more than it used to. It no longer refers chiefly to the provision of vessels, forts and weapons, but rather to the bringing-up of generations of young men trained by school, college, political life and the great national industries to habits of self-direction and of disciplined cooperation. This bringing-up is best secured under free institutions, which leave everything possible to the initiative of the citizen.

This principle—that government should do nothing which any other agencies can do as well—being admitted and established, the next question to be considered is whether the legitimate activities of our government in time of peace, activities directed toward constructive and wholly beneficent objects, should not be increased. On this point I cannot help thinking that the lesson of the war is plain and convincing. It is undeniable that our people have rejoiced in the exhibition of power which the government has given during this war. We have all derived great satisfaction from our government's display of power, exercised with promptness, foresight and the sagacious adaptation of means to ends. It is human nature always and everywhere to enjoy such success as the government has won, even when it costs heavily in blood and money. To have the consciousness of possessing power, and to display the power possessed, is a national gratification. Now, this sort of satisfaction ought to be obtainable in peace as well as in war; so that the power of the United States, displayed in peace for ends wholly constructive and beneficent, ought to be in some measure comparable with the power the government is capable of displaying for destructive ends in war. How can the United States put forth, during the long periods of peace, a beneficent power comparable to the destructive power it wields in war, without violating the principle of leaving to its citizens every field of activity which they can till to advantage.

If we examine the fields of activity which must perforce remain to the government we shall find that they will amply suffice for the exercise of power enough to gratify the most ambitious and the most benevolent citizen of the Republic. Let us briefly survey some of these fields. The first I shall mention is the fostering of commerce. This function obviously belongs to the general government, which has power not only to regulate, but to annihilate at will, the trade of its citizens with foreign countries. The war with Spain has distinctly enlarged the moral outlook of our people. It has presented to them wholly unexpected problems concerning the responsibility of a fortunate people for the welfare of the less fortunate. It has suggested to them that a policy of political seclusion and commercial isolation is not worthy of a strong, free and generous people, and that such a policy is not the way to the greatest prosperity and the most desirable influence.

Another great field of beneficent activity for our government is the procuring of just and humane conditions of labor in industries which cannot be carried on within the jurisdiction of any single State, because they necessarily cover several States. The great functions of the national government in this respect are now only beginning to be exercised. In the Ninth Annual Report of the Inter-State Commerce Commission on the Statistics of Railways in the United States, a report dated June 30, 1897, I read that in the year 1896 the number of railroad employees killed in the service was 1,861, and the number injured 29,969, the number of men employed on the railroads of the United States in that year being 826,620. In the same year there were killed and wounded in coupling and uncoupling alone 6,614 trainmen, 1,744 switchmen and flagmen, and 328 other employees, making a total of 8,686 killed and wounded in coupling and uncoupling alone. Do not

these terrible figures suggest that our government has not yet undertaken to discharge its duty of protecting by legislation large classes of its citizens engaged in indispensable service to the community?

As time goes on, it appears that more and more industries have a national scope. Thus, it may be doubted whether the mining of soft coal can be successfully regulated by the separate legislation of single States; for coal mined in Virginia is necessarily in competition with coal mined in Ohio, for example, and the unprotected condition of laborers in Ohio may prevent the adequate protection of coal miners in Virginia. Interests common to many States certainly suggest that the common government has duties in regard to them.

An established function of our national government is the execution of public works for the improvement of rivers and harbors—works which redound to the advantage of the localities where they are situated, to be sure, but also to that of the people at large. These works are too often executed in a slow, wasteful manner, which no private person or corporation could possibly afford. As an illustration of bad government methods, and, therefore, of the possibilities of improvement in governmental efficiency, I take the Columbia River at the Cascade Gorge. This improvement comprises works on a lock and on a canal about three thousand feet long. The original estimate of the cost was a million and a-half dollars, and the work was actually begun in 1878. At the end of 1891, when $1,609,324.94 had been expended on the work, the estimate for its completion was a million and three-quarters dollars. It is not yet finished, after the lapse of twenty years. It is impossible for the nation at large to take satisfaction in grand works so feebly conducted. Such a process impairs, rather than increases, the self-respect of the nation; for everybody perceives that it is a stupid and discreditable process. Whenever a public work must be completed before the country can derive any benefit from it the government should prosecute the work with all the dispatch consistent with thoroughness of execution. This single instance illustrates the opportunities which exist for immense improvement in the conduct of the operations of our government on public works.

To illustrate further the directions in which the beneficent expenditures of our government might reasonably increased, I now invite your attention to certain comparisons between items of military and naval expenditure which the war has forced on our attention, and the cost of some government establishments which are of special interest to the Association. The annual cost of the lighthouse establishment, on the average of the five years from 1893 to 1897 inclusive, was three million dollars. The cost of maintaining naval vessels in commission during the year 1897—a year of peace—was nine millions of dollars. Now, the lighthouse establishment is one of the most interesting and useful departments of national expenditure. It has a high scientific quality, and also a protecting, guiding, friendly quality. It calls forth in high degree the best human qualities—intelligence, fidelity and watchfulness. With our resources and our commercial needs, and our thousands of miles of coasts and rivers, our lighthouse establishment ought to be the best in the world, as well as the most extensive. Indeed, it ought to be absolutely as good as it can be made.

The progress of medical science imposes upon modern governments a new duty toward their citizens—the duty, namely, of protecting them from contagious or infectious diseases. This protection has to be provided by means of inspection stations, quarantines and other methods proper to secure the isolation of infected persons.

The diseases against which protection is most to be desired are cholera, smallpox, leprosy and yellow fever; and these diseases come in at the coast on vessels which are sailing under national authority and regulation. It is impossible to see how an effective control can be exercised over them except by the national government. Now that our government has driven Spain out from its West Indian possessions, and has assumed possession of Porto Rico and temporary control of Cuba, an opportunity is afforded of organizing this department and putting it upon a much more effective footing than would have been possible before. The island of Cuba has been the great source of yellow fever infection, and we now have, temporarily at least, the opportunity of ridding ourselves of this source of danger and dread. At the same time Congress can reconstruct what is now called the Marine Hospital Service, and render it, under some other name, a thoroughly effective agent for the protection of the people of the United States from imported preventable diseases. An effective bureau once established would undoubtedly find new opportunities of usefulness to the people. The preservation of the public health against the invasion of preventable disease is really one of the great interests of the American people, health and the protection of life to the normal period being infinitely precious to the individual and desirable alike for the happiness and the productiveness of the whole people. Indeed, the public health more directly concerns the public happiness than does agriculture, mining, trade or any other of the national activities. The present expenditure of the government for the Marine Hospital Service has been about $650,000 a year, on the average for the five years 1893 to 1897. This budget ought to be greatly increased. It would be wholly reasonable for the government to spend as much on behalf of the public health as it costs to keep three battleships in commission for a year in time of peace, say, one million of dollars.

The Life-Saving Service of the United States deserves to be greatly enlarged. The seacoast of the United States is of great extent, even if we do not include the deep indentations of a coast like that of Maine. On June 30, 1895, the number of life-saving stations was only 251, and of these 251 stations 53 were on the Great Lakes, 1 on the Ohio river and 13 on the Pacific coast. The mere mention of these figures demonstrates at once the inadequacy of the number of stations. The men employed must possess skill in surf-work and in the use of the various appliances for life-saving, and must be also men of unquestionable courage and good judgment. They are exposed in their routine of duty to many hardships and dangers. They struggle with wind and cold on the shore, and with some of the most formidable dangers of the sea. They must patrol beaches or rock-bound shores in the worst weather, and must be always ready for prompt service by night and by day. They need all the martial virtues, and these virtues are displayed not in killing and wounding, but in rescuing from death and injury. Shall we not all agree that this noble service should not be limited in its scope by any pecuniary consideration, but only by the probability of rendering service?

The Department of Agriculture is of comparatively recent creation, dating from 1893. The proper objects of the department are the discovery, study and development of the agricultural resources of the United States. It is primarily a scientific and technical department. Its main work is not done in Washington, but at scattered stations all over the country. Thus, there are outside of Washington 154 observing

stations and 152 signal stations of the Weather Bureau. There are also 152 meat-inspection stations in different towns and cities of the country, 21 quarantine stations for imported cattle, 9 stations for inspecting exported stock and 19 for inspecting stock for Texas fever. The division of statistics affords a measure of protection against combination and extortion in buying and selling the products of agriculture. When we consider the large proportion of our population engaged in industries which this department serves, and the importance of these industries to our national budget, may we not reasonably be surprised that the department is crippled by the parsimony of Congress with regard to salaries? On account of the low salaries authorized for scientific and technical services, the department is constantly losing some of its ablest and best workers. Apart from the Weather Bureau, which is now one of its divisions, the cost of the Department of Agriculture during the financial year 1896–97 was rather more than two millions of dollars—about the cost of one day of the war with Spain.

Next to agriculture in importance to the country comes the mining of coal and the metallic ores. The mineral wealth of the United States, including coal, is immeasurable, and there lie the foundations of all our manufacturing industries, and of the household comfort with which our population is so greatly blessed. One would naturally have supposed that the government of the United States would have been inclined to spend liberally on the discovery and investigation of our mineral resources, but such has not been the history of the Geological Survey of the United States. The expenditure upon it has never been generous, and has often been parsimonious. For the average of the five years 1893–97 the expenditures of the government on the Geological Survey and the issue of geological maps was about $450,000 a year, or less than the cost of six hours' war with Spain during the last four months.

The Weather Bureau of the United States, on which the nation spends less than a million dollars a year, contributes greatly to the comfort and health of the people and to the protection of their property, yet its number of stations for weather observation is manifestly insufficient, and the number of places at which warnings are conspicuously given is also insufficient. In the year ending June 30, 1897, that is, before the war, the country spent twice as much on mere repairs of naval vessels as it did on the Weather Bureau.

The coast and Geodetic Survey of the United States has often been crippled in its work by lack of steady, timely and adequate appropriations. Its annual cost for the five years 1893–97 averaged $418,000, or only a little over what it cost to maintain in commission the armored cruiser New York for the year 1697.

A new department of our government ought to be at once organized to secure the permanent protection and utilization of the forests on the national domain. The experience of other nations has already demonstrated that well-managed national forest reserves not only pay their expenses, but yield a revenue. The objects of such forest administration are of the utmost importance to a mining and farming population, being briefly, to ensure a permanent supply of timber, to protect the water-supply in agricultural regions adjacent to the forests, to prevent floods and to store water which in arid and semi-arid regions can subsequently be utilized for irrigation. The efforts thus far made to protect the national property in forests have not been successful, the greatest destruction being wrought, first, by fire, and secondly, by pasturage, but much harm being done by simple stealing of the forest product in districts where

there is no adequate policing of the reservations. In arid or semi-arid regions reforesting, when once the original timber has been removed, is extremely difficult or in many cases impossible. Anyone who has traveled through the comparatively treeless countries around the Mediterranean, such as Spain, Sicily, Greece, northern Africa, and large portions of Italy, must fervently pray that our own country may be preserved from so dismal a fate. A good forest administration would soon come to support itself; but it should be organized in the interest of the whole country, no matter what it may cost. The estimate of the cost of the organization, as made by the Forestry Commission of the Academy, was two hundred and fifty thousand dollars a year for the first five years. This is about the annual cost of the maintenance of the protected cruiser San Francisco.

The government has carried on for many years past an inquiry into the habits, feeding grounds and modes of breeding and migration of the fish which make an important part of human food, and inhabit the western Atlantic and the eastern Pacific, the Great Lakes and the rivers and brooks of the continent. It is obvious that no power but that of the general government can carry on effectively a research of this magnitude, covering such enormous areas and dealing with such a variety of creatures, and it is obvious that such researches require expensive outfit, long time and highly-trained observers. Now, in this great enterprise the expenditures of the government during the five years 1893–97 have been $360,000 a year, which is less than the annual cost of maintaining one of our battleships.

One other mode of beneficent expenditure the United States government has maintained for a generation, namely, the annual appropriation of money for certain colleges of agriculture and mechanic arts, which were founded under the Act of 1862. In aid of these colleges the government appropriated in 1897 a million of dollars. Can any one of us see with satisfaction our government spend as little on the annual support of education in agriculture and the mechanic arts throughout the country as on the annual maintenance of three battleships in time of peace?

In instituting these comparisons between military and naval expenditure, on the one hand, and expenditure for purely beneficent objects, such as the advancement of science, the development of technical skill, the saving of life, the improvement of industries, and the support of education, on the other, I have no intention of even suggesting that the expenditures on military and naval preparation should be diminished, much less stopped, as Charles Sumner proposed. As war becomes more and more a matter of science—chemical, physical, biological and fiscal—and of highly-trained skill on the part of all who direct or operate the complicated machinery of war, it is manifest that it is the duty of the United States to build and maintain the most perfect instruments and appliances of war that the utmost skill of our engineers and mechanics can produce, and to keep in training adequate bodies of men to use effectively this elaborate machinery. But is it not equally clear that the nation which can afford to make this expenditure can afford to make much freer expenditures than our nation has ever made on the wholly beneficent agencies of the government, which save life, increase food and ore production, avert evils, facilitate transportation, promote industries and commerce, and foster education.

After everything possible has been said in favor of martial virtues and achievements, whenever our people really take up the question how best to win glory, honor and love for free institutions in general,

and the American Republic in particular, whether in our own eyes or in the eyes of other nations and later times, they will come to the conclusion that more glory, honor and love are to be won by national justice, sincerity, patience in failure and generosity in success than by national impatience, combativeness and successful self-seeking—and glory, honor and love more by as much as the virtues and ideals of civilized man excel those of barbarous men.

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*A HALF-CENTURY OF EVOLUTION, WITH SPECIAL REFERENCE TO THE EFFECTS OF GEOLOGICAL CHANGES ON ANIMAL LIFE** (*II.*).

THE APPALACHIAN REVOLUTION AND ITS BIOLOGICAL RESULTS.

UNLESS we except the great changes in physical geography which took place at the end of the Tertiary period, when the mountain chains of each continent assumed the proportions we now see, the Appalachian revolution, or the mountain-building and continent-making at the close of the Paleozoic age, was the most extensive and biologically notable event in geological history. In its effect on life, whether indirect or direct, it was of vastly greater significance than any period since, for contemporaneous with and as a consequence of this revolution was the incoming of the new types of higher or terrestrial vertebrates. Through the researches, now so familiar, in the field and study of the two Rogerses, of Dana and of Hall, we know that all through the Paleozoic era at least some 30,000 to 40,000 feet of shoal water sediments, both marine and fresh-water, derived from the erosion of neighboring lands, were accumulated in a geosynclinal trough over the present site of the range extending from near the mouth of the St. Lawrence to northern Georgia. At the end of the era ensued a series of movements of the earth's crust resulting from the weight of this vast accumulation, which in a geologically brief period sank in, dislocated and crushed the sides of the trough, and folded the strata into great close parallel folds, besides inducing more or less metamorphism. These folds rising from a plateau formed mountain ranges perhaps as high as the Sierra Nevada or Andean Cordillera of the present day. The plateau emerged above the surface of the Paleozoic ocean, and was carved and eroded into mountain peaks, separated by valleys of erosion, the rivers of the Appalachian drainage-system cutting their channels across the mountain ranges.

But this process of mountain-building and erosion was not confined to the end of the Paleozoic era. Willis * has shown that there were several successive cycles of denudation, covering a period extending from the end of the Paleozoic era to the present time. And it is the fact of these successive cycles of denudation both on the Atlantic and Pacific slopes of our continent that is of high significance to the zoologist from the obvious bearings of these revolutions on the production of variations. Indeed, it is these phenomena which have suggested the subject of this address.

We can imagine that this great plateau, in the beginning of the Mesozoic era, with its lofty mountain ranges and peaks rising from the shores of the Atlantic, presented different climatic zones, from tropical lowlands, with their vast swamps, to temperate uplands, stretching up perhaps to alpine summits, with possibly glaciers of limited extent filling the upper parts of the mountain valleys. New Zealand at the present day has a subtropical belt of tree ferns, while the mountains bear glaciers on their summits ; and in Mexico, only about

* Address of the Vice-President before Section F—Zoology—of the American Association for the Advancement of Science, August, 1898 ; continued from SCIENCE, August 27th.

* National Geographic Magazine, 1889, Vol. I., pp. 291–300.

20° from the tropics, rising above the tropical belt, is the temperate plateau, and farther up the subalpine snow-clad summits of Popocatapetl, Orizaba and other lofty peaks. So in the Appalachians of the Paleozoic the cryptogamous forests and their animal life may have been confined to the coastal plains and lowlands, while on the higher, cooler levels may have existed a different assemblage of life; and it is not beyond the reach of possibility that a scanty subalpine flora peopled the cooler summits.

But the unceasing process of atmospheric erosion and river action continued through the Jurassic, which was, as stated by Scott, in his Introduction to Geology, 'a time of great denudation, when the high ranges of the Appalachian mountains were much wasted away, and the newly upheaved, tilted and faulted beds of the Trias were deeply eroded.' At about the time of the opening of the Cretaceous the range was reduced to a peneplain (the Cretaceous peneplain), with only vestiges of once lofty mountains; the scenic features roughly recalling those of North Carolina and New England at present, although more subdued and featureless, more like the Kittatinny peneplain of the Piedmont district at the eastern base of the Blue Ridge to-day as contrasted with the present mountain region of Pennsylvania and New Jersey. There were also extensive changes in the interior. What was the Colorado island was added to the mainland, and a great Mediterranean sea extended from the Uinta mountains of southeastern Wyoming to New Mexico and Arizona, and stretched from the Colorado peninsula westward to Utah. In the upper Jurassic as the result of a depression a gulf was formed over northern Utah, Wyoming and southern Montana (Scott).

The formation of this Cretaceous peneplain was succeeded by a re-elevation, and the surface which is now Virginia was gradually raised to a height of 1,400 feet, and again the sluggish rivers of the Cretaceous times were revivified, cutting through the harder strata forming the walls of the longitudinal valleys and, widening into broad estuaries, emptied into the Atlantic.

In the Eocene Tertiary, as Willis tells us: "The swelling of the Appalachian dome began again. It rose 200 feet in New Jersey, 600 feet in Pennsylvania, 1,700 feet in southern Virginia and thence southward sloped to the Gulf of Mexico." In consequence of the renewed elevation the streams were revived; and Willis adds: "Once more falling swiftly they have sawed, and are sawing, their channels down, and are preparing for the development of a future base-level."*

We can in imagination see, as the result of these widespread physical changes, inducing as they must have done the formation of separate basins or areas enclosed by mountain ranges, with different climates and zones on land, however uniform might have been the general temperature of the world at that time and the other physical conditions of the sea—we can imagine the profound and deep-seated influence thus exerted on the life-forms peopling the uneven surface of the land.

The vegetation of the lowlands was rich and luxuriant, as the Triassic (Newark), coal deposits near Richmond testify, and, while the uplands and hills were probably clad with dense forests of conifers, on the dryer desert areas of the peneplain the trees may have been more scanty, like the scattered pines of the dryer elevated region of the Southwest and of the Great Basin at the present day. The distribution of the animal life must have corresponded; one assemblage, especially the amphibians, characterizing the hot and humid lowlands;

*Quoted from Scott's Introduction to Geology, p. 342.

another the cooler uplands, while already erhaps a few for ms became adapted to the more arid desert areas, as is the case now in Australia, which is in a sense a Mesozoic continent.

Similar subsidences and elevations changed the Jurassic map in Eurasia. This continent was already a land mass of great extent, and fresh-water lakes extended across Siberia, and in China were extensive swamps and submerged lands, now represented by coal fields. Afterwards in the middle Jura this continent subsided, and the Jurassic sea covered the greater part of Europe and Asia, this being, according to Neumayr, 'one of the greatest transgressions of the sea in all recorded geological history.' Subsidences and elevations resulted, it is supposed, in cutting off India from Eurasia, so that the strait or sea covered the site of the Himalayas, and India was possibly joined to Australia, the Malaysian peninsula forming the connecting link; or perhaps it stretched to the southwestward and was joined to South Africa. However this may be, it is sufficient for our present purpose that these vast changes in the relative position of land and sea were productive of a corresponding amount of variation and perhaps of immigration and consequent isolation. At all events, throughout the Jurassic seas as a whole there seemed to have been remarkable faunal differences. This led Neumayr, in which he is followed by Kayser,* to conceive that there were already in Jurassic times climatic zones corresponding to the boreal, polar, north and south temperate and tropical zones of the present day. If, however, with Scott, we reject this view and substitute for it the supposition that 'the marked faunal differences are due to varying facies, depth of water, character of bottom, etc., and even more to the partly isolated sea-basins and the changing connections which were established between them,' it is of nearly the same import to the geological biologist, for these varying conditions of the Jurassic ocean bottom could not have been without their influence in causing variation, modification and adaptation to this or that set of conditions of existence.

Turning now to the effects of the Appalachian revolution on the life of that time we see that the biological results were, in the main, in conformity with the geological changes. During the Carboniferous period vertebrates with limbs and lungs appeared, *i. e.*, the labyrinthodonts or Stegocephala. They were, compared with the other orders of their class, the most composite and highly organized of the Amphibia.

Throughout the long period of comparative geological quiet, those long ages of preparation which ended in the crisis or cataclysm which closed the Paleozoic, the amphibian type was slowly being evolved in the swamps and bayous of the lowlands of the Devonian, whose vegetation so nearly anticipated that of the Carboniferous from some Devonian* or late Silurian ganoids, from which diverged on the one hand Dipterus and the colossal lung-fish (Dinichthys and Titanichthys, of the Devonian, and perhaps on the other the labyrinthodonts, which may have sprung from some crossopterygian fish like Polypterus, and whose pectoral and ventral fins became adapted for terrestrial locomotion. The type was evidently brought into being provoked by, and at the same time favored by, the great extent of low coastal swampy land and bodies of fresh water which bordered the Atlantic seaboard from the Silurian time on.

How the amphibian type arose from the ganoid stock is a matter of conjecture. It

*Text-book of Comparative Geology, translated and edited by Philip Lake, p. 270, 271.

* Certain footprints recently discovered in the upper Devonian show that the type had become established, at least vertebrates with legs and toes.

may, however, be surmised that certain of the lung-fishes or forms like them, adapted for breathing the air direct when out of the water in the dry season, instead of remaining in their mud cells waiting for the rains to fill the lakes or swell the rivers, attempted, like the Anabas, or climbing fish, to migrate in schools overland; or, like that fish, which is said to have become "so thoroughly a land animal that it is drowned if immersed in water," it may have become confined to the land, and, losing its gills, used its lungs only. As a final result of its efforts to walk over the damp soil and mud of swampy regions the unaxial fins may have developed, through the strains and pressures of supporting the clumsy body, into props with several leverage systems; the basalia, instead of remaining in one plane as in a fish's fin, spreading out and becoming digits to support the weight and steady the body while walking. This process was not confined to one or to a few individuals, but, as Lamarck insists in the cases he mentions, it affected all the individuals over a large area. Those individuals with incipient limbs became erased or swamped, and we find no trace of them in the strata yet examined.

Thus far, indeed, Paleontology is silent† as to the mode of origin of the amphibian limb, as it is concerning the origin of arthropod limbs from the parapodia of annelids. Unfortunately, and this is still a weak point in the evolution theory, nowhere do we find, unless we except the Archæopteryx, clear examples of any intermediate forms between one class and another; each species as far as its fossil remains indicate seems adapted to its environment.

There are numerous cases of vestigial structures, but no rudimentary ones showing distinct progressive steps in a change of function. Hence arises the very reasonable view held by some that nature may make leaps, and that new adaptations or organs may be suddenly produced. No inadapted plant or animal as an entire organism has ever been observed either among fossils or existing species. Man has some seventy vestigial structures, but his body as a whole, notwithstanding the disadvantages of certain useless vestiges, is in adaptation to his physical and mental needs.

While the true Carboniferous labyrinthodonts were few and generalized, with gills and four legs; already in the Permian, where we meet with some thirty forms in the Ohio beds alone, and about as many in Bohemia, a great modification and specialization had taken place. Forms like Peleon and Branchiosaurus had gills and four legs; others were like our lizards, as in Keraterpeton; Dendrerpeton and Hylonomus of Nova Scotia were more lizard-like and with scales; others perhaps swam by means of paddles as in Archegosaurus; others, like the 'Congo snake,' were snake-like with small weak legs, as Œstocephalus; some had gills but no legs, as in Dolichosoma, while in others the limbless body was snake-like and scarcely larger than earth worms, as in Phlegethontia of the Ohio and Ophiderpeton of the Bohemian coal measures.

Already, then, in Permian times the stegocephalous type showed signs of long occupation, old age and degeneration. The process of degeneration and reduction in and loss of limbs may have been initiated as far back as the closing centuries of the Devonian.

*Parker and Haswell's Text-book of Zoology, Vol. II., p. 220.

† Paleontology is also equally silent as to the origin of plesiosaurs and ichthyosaurs from their terrestrial digitigrade forbears, though in Archæopteryx we have an unusually suggestive combination of reptilian and avian features. Certain Theriodontia point with considerable certainty to the incoming of mammals, such as the Echidna and duckbill, but as to the steps which led to the origin of the brachiopods, echinoderms, trilobites, of Sirenians and of whales paleontology affords no indications.

The effect of the Appalachian revolution and corresponding physical changes in Europe was by no means disastrous to the Stegocephala, for those of the Liassic, where the conditions must have been more formidable to terrestrial vertebrate life, were abundant, and in some cases at least colossal in size. Whether the salamanders, cœcilians, sirens and Amphiuma of present times are persistent types, survivors of Carboniferous times, or whether the process of modification has been accomplished a second time within the limits of the same class, is perhaps a matter for discussion.

Besides the introduction and elaboration of the air-breathing, four-footed labyrinthodonts, the sloughs and sluggish streams were alive with Naiadites and its allies, forerunners of the Unionidæ, and with them lived shelled Phyllopods, Estheria having already appeared in the Devonian, Leaia appearing in the Carboniferous; and also the larvæ of aquatic net-veined insects, fragments of the imagines of which were detected by Hartt at St. John, New Brunswick.

The coal-bearing strata are largely fresh-water beds of fine shale and well calculated to preserve the hard parts of delicate animals, but on general grounds it is evident that the great extent of low lands with extensive bodies of fresh water, communicating with the shallow sea, was most favorable to the development and differentiation of terrestrial life. Though fresh-water and land shells (pulmonates) appeared in the Devonian, they were apparently more abundant in the coal period. Especially rapid was the incoming of the arthropods; both diplopods, some of them very remarkable forms, and chilopods lived sheltered under the bark of colossal lycopods; with them were associated scorpions, harvestmen and spiders. The great profusion of net-veined insects discovered at Commentry, France, shows that this was the age of the lower more generalized or heterometabolous insects, such as cockroaches and other Orthoptera, of Eugereon, may-flies and possibly dragon-flies, etc., our wingless stick-insects being then represented by winged ancestors. At this time also began the existence of insects with a complete metamorphosis, as traces of true Neuroptera and the elytra of a beetle have been detected in Europe. But thus far no relics of flowers or of the insects which visit them have been discovered in Carboniferous times, not even in the Permian, so that the origin of insects with a complete metamorphosis, such as moths, ants and flies, may be attributed to the new order of things, geographical and biological, immediately following the Appalachian revolution.

We do not wish to be understood as implying that the origin of new orders and classes is directly due to geological crises or cataclysms themselves.* On the contrary, the initial steps seem to have been taken as the result of the gradual extension of the land masses and the opening up of new areas; it was the period of long preparation, with long-continued oscillations, the slowly induced changes resulting from the reduction of the mountainous slopes to peneplains, which were most favorable to the

* I find that Wood has already expressed the same idea more fully, as follows: "Both in the palaeozoic and secondary periods, therefore, the complete changes in the fauna which marked their termination do not appear to have been immediate upon the changes of the geographical alignement, but to have required the lapse of an epoch for their fulfilment; and the completeness of that change is perhaps not less the indirect result of the altered alignement, by the formation of continents where seas had been, and the opening out of new seas for the habitation of marine animals, thereby causing a gap in the geological records so far as they have been hitherto discovered, than the direct result of the changed conditions to which the inhabitants of the seas, and even those of the land, came to be subject on account of the entire change in the alignement of the land over the globe." (*Phil. Mag.*, XXIII., 1862, p. 281.)

gradual modification of forms resulting in new types, the gradual process of extinction of useless and senile forms, and the modification and renewal of those which became adapted to the new geographical conditions.

It should be borne in mind that this extension of the low coasts of the continents began in Ordovician times, but the remarkable expansion of our continent after the Appalachian revolution, rather than the upheaval of the plateau itself, so favorably affected plant and animal life that at the dawn of the Mesozoic a great acceleration in the process of type-building was witnessed. Moreover, it seems evident that the variation which took place at this epoch was by no means fortuitous, but determined along definite lines caused by the definite expansion of the continents and their resultant topography.

We have seen that, as a result of the folding and upheaval of the Appalachians, there may have been at the beginning of Triassic time, in addition to the tropical lowlands, a somewhat cooler upland zone, and possibly even snow-clad mountain peaks, with glaciers descending their sides, as we may now witness in New Zealand.

Already on Permian soil reptiles were not infrequent. They were generalized composite forms comprising the Proganosauria, the forerunners of the Hatteria of New Zealand, and the Theriodontia, from which the mammals are now supposed to have been derived. They disappeared at the end of the Triassic, together with the labyrinthodonts, from which the reptiles are thought to have originated. These reptiles having scaly bodies and claws, their habits must have been like those of the lizards of to-day, and they were adapted for hotter and dryer, perhaps more elevated, areas than the stegocephalous amphibians; and these conditions were fulfilled in Triassic and Jurassic times, when the reptilian orders multiplied, all the orders of the class having been differentiated in the Mesozoic era, if not before.

The geographical features throughout the Mesozoic were these: more or less dry and broad plains, vast fresh-water lakes, uplands clad with coniferous forests afterwards to be replaced by forests of deciduous trees; flower-strewn plains overgrown with waving grasses, and jungles with rank growths of bamboo. We can, without going into detail, well imagine that the geographical features of the Mesozoic continents were such as to provoke the appearance of the higher classes of vertebrates. As the land rose higher and the low, swampy coastal areas became more limited, this would tend to restrict the habitat of the stegocephalous amphibians; with a slightly more elevated and dryer coast the incoming and expansion of reptilian life were fostered; with still higher plains and hills, besides the increasing abundance of flowers and other seed-bearing plants and of the insects which visit them, existence for birds became possible, and with them that of a few scattered mammals of small size and generalized structure, with similar insectivorous habits.

During the age of reptiles, when they swarmed in every jungle, throughout the forests and over the plains, competition rose so high that some of them were forced to take flight, and bat-like, provided with membranous wings, the pterodactyls lived in a medium before untried by any vertebrate, and finally there appeared in the Ornithostoma of the Cretaceous a colossal flying reptile, its wings spreading twice as much as any known bird, with a head four feet in length; its long toothless jaws closing on swarms of insects or perhaps small fry of its own type. But the experiment in point of numbers or capacity for extended flight did not succeed. Another type assayed the problem with better success. There appeared feathered and eventually toothless vertebrates with the fore

extremities converted into pinions and the hinder ones retaining the raptorial reptilian form better adapted for aërial life. They eked out a by no means precarious existence on flying insects and seeds, as well as on the life in the soil or by the seaside, and rapidly replaced certain older reptilian types. The class of birds has become about four times as numerous as the reptiles, and outnumbers the mammals nearly six times.

We may now review the zoological changes which took place at the time including the end of the Paleozoic and the opening of the Mesozoic. There was an extinction of the Tetracoralla and their replacement by corals with septa arranged in sixes; an extinction of cystidian and blastoid crinoids, the dying out of old-fashioned crinoids and echinoids (Palæocrinoidea and Palæechinoidea), followed by the rise of their more modern specialized successors. As rapidly as the brachiopods became diminished in numbers their place at the sea-bottom was taken by the more active and in some cases predatory bivalve and univalve molluscs. As the trilobites became extinct their place in part was filled by their probable descendants, the Limuli, which had already begun to appear, the earliest types being Neolimulus, Exapinurus and other forms of the Silurian, and Protolimulus of the Devonian. The Limuli of the Carboniferous, some with short (Prestwichia and Euproops) and others with long tail-spines (Belinurus), suggest long possession of the soil and consequent variation and differentiation.

The Eurypterida shared the fate of the trilobites, and while there was a thorough weeding out of the more typical ganoids, leaving an impoverished assemblage to live on through after ages, that singular primitive vertebrate group, the Ostracodermi, was wholly obliterated.

On the other hand, with the incoming of a new order of vegetation, a great outgrowth of winged insects, the representatives of the orders of Lepidoptera and Hymenoptera, now so numerous in species, began their existence.

By the close of the Appalachian revolution probably all the orders of insects had originated, unless we except the most modified of all, the Diptera, whose remains have not been detected below the Lias. With but little doubt, however, the eight orders of holometabolous insects diverged in the Permian, if not near the close of the Carboniferous, from some protoneuropter; the progress in the differentiation of genera and families becoming rapid either during the Jurassic or directly after the lower Cretaceous, or as soon as grasses and deciduous trees became in any way abundant.

Very soon, too, after the close of the revolution the ancestral birds and mammals diverged from the reptiles, and of the latter the turtles, plesiosaurs, ichthyosaurs, crocodiles and dinosaurians, and soon after the pterodactyles, came into existence.

As a result of this revolution the molluscan type was profoundly affected, as at the opening of the Triassic siphoniate Pelecypoda, opisthobranchiate Gastropoda and cuttles or belemnites appeared. While a few Orthoceratites lingered on after the revolution, the Ammonites blossomed out in an astonishing variety of specific and generic forms.

In summing up the grand results of the Appalachian revolution and of the times immediately succeeding, we should not lose sight of the fact that the changes in the earth's population were due no less to biological than geological and topographical factors. This process of extinction was favored and hastened by the incoming of more specialized forms, many of them being carnivorous and destructive, as, for example, nearly all fishes and reptiles live on other animals. The

struggle for existence between those which became inadapted and useless in the new order of things went on more actively than at present. The process of extinction of the higher, more composite amphibians (the labyrinthodonts) was largely completed by the multitude of theromorphs and dinosaurs which overcame the colossal Cheirotherium, Mastodonsaurus and their allies.*

During the centuries of the Trias the lowlands became crowded, and the reptilian life was forced in some cases to gain a livelihood from the sea, for at this time was effected the change from small terrestrial reptiles like Nothosaurus to the colossal pleisosaurs and ichthyosaurs, in which digitate limbs were converted into paddles, and the ocean, before this time uninhabited by animals larger than ammonites, cuttles and sharks, began to swarm with colossal vertebrates, the increased volume of their new and untried habitat resulting in a tendency to a corresponding increase in weight, just as whales which possibly evolved from some land carnivora in the early Tertiary waxed great in bulk, the increase in size, perhaps, having been due to the great volume of their habitat, the ocean.

Nothing so well illustrates the advantage to an incipient type as entering a previously uninhabited topographical area, or a new medium, such as the air. In the case of the pterodactyles, the first vertebrates to solve the problem of aërial flight, originating and prospering in the early Mesozoic, they held their own through the Cretaceous, where at their decline they became, as in Ornithostoma, colossal and toothless. We can imagine that the demise of this type was assisted in two ways; those with a feebler flight succumbed to the agile, tree-climbing dinosaurs; while the avian type, waxing stronger in numbers and power of flight and exceeding in intelligence, exhausted the food supply of volant insects, and drove their clumsier reptilian cousins to the wall, fairly starving them out, just as at the present day the birds give the bats scarcely a *raison d'être*.

*After writing the above lines I find the same view expressed in Woodworth's Base-leveling and Organic Evolution. He remarks: "The exact cause of their decline is probably to be sought in the development of the more powerful reptilia" (p. 225). Regarding the circumstances favorable to reptilian life, he also states: "In the development of the peneplain from the high relief of the Permian and again at the close of the Jura Trias the widening out of the lowland, with plains and jungles, near tide-level, followed by depression of the land, must have highly favored the water-loving reptilia. It is to these geographical circumstances, I think, that we must look for our explanation of the remarkable history of this class in Mesozoic times" (p. 226).

3. THE PACIFIC COAST REVOLUTIONS.

It has long been known that there are a greater number of insect faunæ on the Pacific coast and greater variation of species, with more local varieties, than east of the Mississippi river. It has also been shown by Gilbert and Evermann, as well as by Eigenmann, to apply to the fishes of the Columbia and Frazer river basins. "Nowhere else in North America," says the latter, "do we find, within a limited region, such extensive variations among fresh-water fishes as on the Pacific slope." He also points out the noteworthy fact that the fauna is new as compared with the Atlantic slope fauna, and 'has not yet reached a stage of stable equilibrium.' As previously shown by Gilbert and Evermann, "each locality has a variety which, in the aggregate, is different from the variety of every other locality;" and he adds: "The climatic, altitudinal and geological differences in the different streams, and even in the length of the same streams, are very great on the Pacific slope."

It is evident that the variations are primarily due to the broken nature of the Pacific coast region, and to the isolation of the animals in distinct basins more or less

surrounded by high mountain barriers, with different zones of temperature and varying degrees of humidity.

As brought out by the labors of Le Conte, Diller and Lindgren, the Sierra Nevada region has undergone cycles of denudation, and these changes, occurring later than those of the Appalachian region, have doubtless had much to do with the present diversified and variable fauna. The latest writer, N. F. Drake,* states that the western slope of the Sierra Nevada "was probably once a region worn down almost to base-level or to a peneplain. By the uplift of the mountains a great fault was developed along the eastern face and the whole Sierra crust-block tilted to the westward. The streams quickened by the uplift again set to work on the peneplain and carried it to its present condition."

Le Conte † states that the Sierra Nevada was upheaved at the end of the Jurassic period. This corresponded to the Appalachian revolution which occurred at the end of the Paleozoic era.

"But during the long ages of the Cretaceous and Tertiary this range was cut down to very moderate height. * * * The rivers by long work had finally reached their base-levels and rested. The scenery had assumed all the features of an old topography, with its gently flowing curves * * * At the end of the Tertiary came the great lava streams running down the river channels and displacing the rivers; the heaving-up of the Sierra crust-block on its eastern side, forming the great fault-cliff there and transferring the crest to the extreme eastern margin; the great increase of the western slope and the consequent rejuvenescence of the vital energy of the rivers; the consequent down-cutting of these to form the present deep canyons and the resulting wild, almost savage, scenery of these mountains."

*The Topography of California. *Journ. of Geology*, V., Sept.-Oct., 1897, p. 563-578.

†*Bulletin Geol. Soc. Amer.*, II., pp. 327, 328.

This view is further carried out by J. S. Diller, from his studies of the northern part of the Sierra Nevada, including the borders of the Sacramento valley and the Klamath Mountains. He shows that northern California, during the earlier portion of the auriferous gravel period, was by long continued degradation worn down to base-level conditions. "The mountain ranges," he says, "were low, and the scenery was everywhere characterized by gently flowing slopes." * * *

"The topographic revolution consisted in the development out of such conditions of the conspicuous mountain ranges of to-day. The northern end of the Sierra Nevada has since been raised at least 4,000 feet, and possibly as much as 7,000 feet, and a fault of over 3,000 feet developed along the eastern face of that portion of the range."*

According to Lindgren the Sierra Nevada was eroded to, or almost to, a peneplain during Cretaceous times, and the mountains elevated in a later Cretaceous period were worn down during Tertiary times merely to a gentle topography.

The other post-Cretaceous changes of this vast region are thus summarized by Scott from the results of Pacific coast geologists. In the Eocene a long narrow bay occupied the great valley of California, extending northward into Oregon and Washington. At the end of the Eocene or early in the Miocene an elevation in California shifted the shore line far to the west. In the Miocene the Coast Range formed a chain of reefs and islands, and at the close an upturning and elevation of the mountain range took place, though it became higher afterwards. The Coast Range sank again early in the Pliocene and the San Francisco peninsula was an area of subsidence and

*14th Ann. Rept. U. S. Geol. Survey, Part II., p. 433.

maximum deposition forming the thickest mass (58,000 feet) of Pliocene in North America. The mountains of British Columbia are believed to have been at a higher level than now, as it is supposed that Vancouver and Queen Charlotte Islands probably formed part of the mainland.

At or near the close of the Pliocene the Sierra Nevada increased in height by the tilting of the whole block westward. New river valleys, cut through the late basalt sheets of the Sierras, are much deeper than the older valleys excavated in Cretaceous and Tertiary times, owing to the greater height of the mountains and to the consequent greater fall of the streams. At this time the Wasatch Mountains and high plateaus of Utah and Arizona were again upraised, and the great mountain barrier of the St. Elias, in southeastern Alaska, was likewise thrown up. At this time also, or perhaps later, the mountains of British Columbia were probably raised still higher.* It will be seen from this that the present topography of the western border of our continent including Central America and the Isthmus of Panama belongs to a new topographic era, and fully substantiates the view that the fauna of these regions is very recent compared with that of the Atlantic border, and that the number of nascent or incipient species is much greater.

ALPHEUS S. PACKARD.
BROWN UNIVERSITY.

(*To be concluded.*)

* *Journal Geol.*, IV., pp. 882, 894, 897 and 898. (Quoted from Drake.)

EARTHQUAKES.

COMMANDANT MONTESSUS DE BALLORE, of the French Army, is well known as an authority on earthquakes in general, and especially on the earthquakes of Central America, where he resided for a considerable time some dozen years ago. Besides his own observations he has discussed thousands of others, collected by himself or taken from the extended lists of Mallet (B. C. 1606 to A. D. 1850), Perrey, Fuchs, etc. All of the available material has been sifted and examined, and then discussed in a scientific fashion, to bring out whatever general laws may underlie the statistics.

A collection of some of M. Montessus' pamphlets has lately come into my hands.* They deserve anextended review, but, failing this, the following notes may be of interest.

The relations between the topography of a country—its topographic relief—and the frequency of its earthquakes has been deduced from 98,868 records of shocks at 6,789 centers distributed in 353 regions of the globe. The most general statements that can be made are as follows:

"Regions of great earthquake frequency lie near the greater lines of corrugation of the earth's crust."

"In any group of adjacent seismic regions the earthquake frequency is greatest in the regions of highest relief."

These very general laws may be put into more special forms that are directly proved by the statistics:

I. Mountainous regions are more unstable than plains.

II. Sea-coasts near oceans that rapidly deepen, especially such as are bordered by high mountains, are more unstable than the coasts of shallow seas, especially if such coasts have no mountains near them.

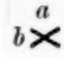
III. The shorter and steeper slopes of mountain chains are the more unstable.

* Relations entre le relief et la sismicité, *Archives des Sciences Phys. et Nat.*, 1895 ; Le Japon sismique, *ibid.*, 1897 ; Les Etats-unis sismiques, *ibid.*, 1898 ; Les Indes Neérlandaises sismiques, *Nat. Tijd. der Kon. Nat. Ver. in Nederlandsch—Indie*, Dl. LVI., 1896 ; Etude critique des lois de répartion saisonnière des séismes, *Mem. de la Soc. "Alzate,"* tomo IV. ; Relation entre la fréquence des tremblements de terre et leur intensité, *Bull. d. Soc. Sismologica Ital.*, Vol. III. ; La peninsula ibérica séismica y sur colonias, *Ann. de la Soc. Española de Hist. Nat.*, tomo XXIII. ; Seismic Phenomena of the British Empire, *Quar. Jour. Geol. Soc.*, Vol. LII., 1896.

IV. The unstable flank of a mountain chain is most unstable in its steepest parts.

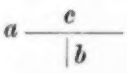
V. The steeper sides of valleys are, likewise, the more unstable.

VI. When two mountain chains cross, making an angle of less than 90°, the area inside the exterior angle is the most unstable.



(The region *a* will have more shocks than the region *b*.)

VII. When a mountain chain (*a*) has a buttress (*b*) the flank opposite *b* is the more unstable (*c*).



VIII. Mountain masses are more unstable on their flanks than within the mass.

IX. Abrupt changes of slope are especially favorable to instability.

X. The highest parts of valleys are frequently more stable than those at the average level, and the lowest parts are generally more stable than those of average level.

XI. Narrow mountainous peninsulas are unstable.

XII. An isthmus in a sunken region is unstable.

XIII. Narrow straits are often the centers of earthquakes.

XIV. Regions of great earthquake frequency usually do not coincide with regions of many volcanoes; or, earthquakes and volcanic phenomena are, in general, independent of each other.

Several of these laws are well known; some of them would be announced by an expert even before seeing the data; but, on the other hand, some of them are genuine surprises. In their collected shape they constitute an important contribution to the subject. Law XIV. is not proved in the pamphlets cited by title, but the first half of it is well known to be true in very many regions of the globe, and the last half follows as a *statistical* consequence.

It is a very ancient opinion that earthquakes are decidedly more frequent at some seasons of the year than at others. Aristotle, for example, declared that the autumn and spring were seasons of frequent shocks, while summer and winter were seasons of few shocks. Perrey, Mallet and others have announced similar laws. From a discussion of 63,555 shocks in 309 regions of the globe M. de Montessus shows that, taking the whole earth together, shocks are equally probable at any season. This general law may not be true for certain special localities, but it is true for the whole earth.

In order to study earthquake statistics to advantage and to compare one region with another it is desirable to have some uniform method of expressing earthquake frequency numerically—of deducing the coefficient of earthquake frequency, as a mathematician might express it. M. Montessus forms such numbers in the following way: The region to be studied is divided into smaller areas. Each of these areas is chosen so as to be fairly homogeneous in physical characteristics, geographically, geologically, etc. The areas are now divided into as many small squares as there are earthquakes per year. The greater the frequency the greater the number of squares, of course. The side of one of these small squares is chosen as the coefficient of frequency,* and the greater the number of shocks per year the smaller is this coefficient. There is something arbitrary in this process; but, at the same time, it leads to results of importance because, after all, it is only the *relative* earthquake frequency that is sought, not the absolute. Of two regions, which is most shaken and in what ratio? is the question to be solved.

In eastern Java, for example, S (the seismic number) is equal to 56 kilometres. That is, there is, on the average, one earthquake per year in each square of 56 kilometres on

* M. Montessus calls it the 'sismicité.'

a side. In western Java $S = 50$ km. There are more earthquakes in this region. It will not be without interest to quote a few of the author's conclusions expressed in this numerical form.

For Porto Rico, $S = 2.3$ km., that is, there is one earthquake annually in each square of 2.3 km. (1.38 miles) on a side on the average.

For the island of Luzon, $S = 2.8$ km.; for Manila, $S = 3.0$ km.; for central Cuba, $S = 41$ km.; for western Cuba, $S = 128$ km.; for Hawaii, $S = 37$ km. These numbers may be compared with others relating to the United States, as central California, $S = 76$ km.; New England, $S = 90$ km.; the Carolinas, $S = 313$ km.; Michigan, $S = 487$ km., or with Tokyo, Japan—one of the most disturbed portions of the globe—for which the number is 12 km. Manila and Porto Rico are far more disturbed than this.

Work of the kind here noticed is valuable in proportion to the care with which the data have been sifted, and to the impartiality of the investigator. It is believed that anyone who will examine the work of M. Montessus carefully will conclude that he has made a considerable step forward.

EDWARD S. HOLDEN.

STOCKBRIDGE, MASS.,
August 15, 1898.

ZOOLOGICAL NOTES.

MR. FRANK FINN, of the Indian Museum, Calcutta, has been making an extensive series of experiments with birds in regard to the value of the so-called warning colors of butterflies. These experiments, which are recorded at length in the *Journal* of the Asiatic Society, are extremely valuable from the fact that while it has been assumed that insects nauseous to man are equally nauseous to birds this has not been sufficiently well proved. In fact, it has been shown by the investigations of the Department of Agriculture that many of the (to us) vile-tasted Hemiptera are greedily devoured by birds. Definite information is also needed as to the extent to which birds actually eat butterflies. The experiments were mainly made with Babblers, *Crateropus*, and Bulbuls, *Otocampsa*, although a few other species were used.

As a result of his experiments Mr. Finn concludes: "That there is a general appetite for butterflies among insectivorous birds, even though they are rarely seen when wild to attack them.

"That many, probably most, species dislike, if not intensely, at any rate in comparison with other butterflies, the 'warningly-colored' *Danainæ*, *Acræa violæ*, *Delias eucharis* and *Papilio aristolochiæ*, of these the last being the most distasteful, and the *Danainæ* the least so.

"That the mimics of these are at any rate relatively palatable, and that the mimicry is commonly effectual under natural conditions. That each bird has to acquire separately its experience, and well remembers what it has learned."

That, therefore, on the whole the theory of Wallace and Bates is supported by the facts and Professor Poulton's suggestion that animals may be forced by hunger to eat unpalatable forms is also more than confirmed.

F. A. LUCAS.

CURRENT NOTES ON ANTHROPOLOGY.

INDETERMINATE FORMS OF CHIPPED STONES.

THERE is a large class of objects which constantly puzzle the antiquary. These are flaked or chipped stones simulating the forms of art effects, yet not positively indicating the work of man.

In a handsome and abundantly illustrated volume of 70 pages M. A. Thieulen publishes a paper read before the Anthropological Society of Paris on a collection of

these objects from the drift of France. He claims that they represent the most common instruments of palæolithic man. They very rarely show distinct secondary chipping or the bulb of percussion; for which reasons his arguments do not seem to have convinced the Society; yet some of the specimens he figures might well pass as human handiwork. (*Les veritables Instruments usuels de l'age de la Pierre.* Paris, Imprimerie Larousse, 1897.)

WAS BUDDHA A MONGOLIAN?

FERGUSSON and others have claimed that the celebrated founder of Buddhism was of Mongolian origin. With an astonishing ignorance of ethnic traits, Fergusson supported this by the bold assertion that in India Buddha is always represented with wooly hair!

Professor E. W. Hopkins, of Yale, in his 'Notes from India' in the last (19th) volume of the 'Journal of the American Oriental Society,' takes occasion to report on this point. Many ancient figures of Buddha have the hair gathered up in little spiral, conch-shaped curls. According to tradition Buddha had curly hair and wore it short. From an examination of many statues it was evidently wavy, but never wooly. In some instances it is colored red. The general evidence is that so far as hair was concerned he preserved the type of the white race, and was equally remote from the Mongolian and the Negro.

MEXICAN ANTIQUITIES.

PROFESSOR FREDERICK STARR is preparing a 'Manual of Mexican Archæology,' which is sure to be a complete and valuable work, and one much needed at this time.

He anticipates portions of it in Vol. VII. of the 'Proceedings of the Davenport Academy of Natural Sciences,' by an article on 'Notched Bones from Mexico,' in which he explains those described by Dr. Lumholtz to be musical instruments (as I also did in SCIENCE, May 27). Another article is on a shell inscription from Tula. It shows a fragment of *Haliotis* shell with four Mayan characters engraved upon it. This leads him to what he calls the 'startling' conclusion that there were trade relations between Tula, at the time of its occupancy, and the Mayan districts. But that fact is well known from Sahagun's 'History;' and the Tula, some forty miles north of Mexico, was surely not Tula the Magnificent, where Quetzalcoatl ruled his million of warriors!

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

NOTES ON INORGANIC CHEMISTRY.

THE place of helium and argon in the periodic system has already caused much discussion, and now, that several other elements of similar nature have been discovered, the conjectures as to what to do with the whole group will be forthcoming doubtless in great profusion. Happily the *mélange* known as the Group VIII. in Mendeléef's table offers a refuge equal to almost any emergency that may arise. One element might exist in this group with an atomic weight somewhere from 1 to 7, another 19 to 23, another or even three between 36 and 39, three more between 80 and 85, three more between 128 and 132, to say nothing of possibilities of higher atomic weight. It is even possible that three elements could exist in place of each of the first two. From their position in the table, nothing could be foretold as to the properties of elements filling these places, save perhaps that their character would be neither positive nor negative (*i. e.*, without chemical affinity?) and that their valence would be zero (*i. e.*, forming no compounds?). These new elements, as far as they have been described, do singularly fulfil these conditions, helium falling into the first place, neon the second, argon and metargon the the third and krypton the fourth. It is,

however, too early for any serious study of the position of at least several of these elements, inasmuch as the question of even their existence is not settled. However, in a recent paper before the Royal Society, Sir William Crookes shows that helium, argon and krypton fall naturally into the periodic scheme of the elements as devised by him, which differs not very materially from that of Mendeléef. In a postscript to his paper printed in the *Chemical News*, Crookes shows that neon and metargon as far as described also fall naturally into his scheme.

THE boiling point of ozone was determined approximately by Olszewski a few years ago as about —106°. More recently Professor L. Troost has made several very accurate determinations, which are described in the *Comptes Rendus*. The temperature at which the liquefied ozone boiled was determined by an iron-constantin couple, and was —119°. This may then be considered the boiling point of ozone at atmospheric pressure.

IT has long been hoped that a study of graphitic acid would lead to better knowledge of the structure of the carbon molecule in graphite. The greatest obstacle has been the difficulty of oxidizing the graphite to graphitic acid. Repeated treatments of graphite with nitric acid and potassium chlorate finally yield but a very small amount of the acid, even if explosions, which are very apt to occur, are successfully avoided. In the last number of the *Berichte* L. Staudenmaier describes a method which consists chiefly in treating graphite that has been partially oxidized by the old method, with a mixture of potassium permanganate and sulfuric acid. In this way the graphitic acid may be rapidly obtained in considerable quantities, and it is to be hoped that its study will now be prosecuted until light is thrown on the graphite molecule and possibly on allotropy in general.

THE question of whether the formula of potassium permanganate should be written $KMnO_4$ or $K_2Mn_2O_8$ has been in the opinion of many chemists unsettled, even though it was recognized that the salt was isomorphous with the perchlorate, $KClO_4$. Even now, in his periodic scheme, Crookes puts both fluorin and manganese into the same group with iron and the platinum metals. The last *Journal* of the Chemical Society (London) contains a research by J. Murray Crofts, of Emmanuel College, on the molecular weights of permanganates, perchlorates and periodates in solution. The salts used were those of potassium and sodium except in the case of the periodate, where the potassium alone was used. The freezing-point method was used, the solvent being Glauber's salt. In every case the molecular weight was that of the simpler formula, so that, as far as solution goes, the formulæ must be considered to be $KClO_4$, KIO_4 and $KMnO_4$.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

BIOLOGICAL STATION OF THE UNIVERSITY OF INDIANA.

MR. A. C. YODER, of Vincennes, Ind., writes that the Indiana University Biological Station, situated at Vawter Park, Ind., closed its work of the summer on August 19th. The Station was organized in 1895 by Dr. Carl Eigenman, of Indiana University. There is a direct connection between the work done at the Station and at the University proper, credit being given at the one for work done at the other. The Station since organized has been located on Turkey Lake, in northern Indiana. Turkey Lake, about seven miles long and two miles wide, is the largest of the numerous fresh-water lakes found in northern Indiana and is two miles north of the divide, separating the St. Lawrence and Mississippi basins. An abundance of biological material can be had from the lakes on both sides of the divide, and thus are offered excellent opportunities for studying the varia-

tion of species and the influence of different environment. The session of 1898 consisted of two terms of five weeks each. Courses were offered in elementary geology, embryology, bacteriology and botany. Thirteen instructors and assistants were engaged.

The appended data show the success and growth of the Station:

In 1695 there were enrolled 19 students and 1 State represented.

In 1896 there were enrolled 32 students and 4 States represented.

In 1897 there were enrolled 68 students and 5 States represented.

In 1898 there were enrolled 105 students and 8 States represented.

Next year the Station will be in Winona Park, at Warsaw, Ind., eighteen miles from the present location. The Winona Park Association will erect the necessary buildings.

CHRISTMAS ISLAND.

IN a recent issue of SCIENCE we reported the return of Mr. C. W. Andrews, of the geological department of the Natural History Museum, from his expedition to Christmas Island. The expedition started about fifteen months ago, and was sent out by Sir John Murray at his own expense. The flora and fauna of the island are believed to have been uninfluenced by man, and therefore the study of these, as well as of the geology of the island, was expected to yield valuable results. We learn from the London *Times* that the results of the expedition are likely to fulfil the highest expectations. Mr. Andrews pursued his labors under the greatest difficulty. The island is 1,200 feet high, but so densely covered with gigantic forest vegetation and bush that the members of the little colony on the shore have never been able to move a mile from home. The only available drinking water is supplied by a spring on the shore, and as the cliffs are lofty and precipitous it is difficult in the extreme to convey the water into the interior. This will give some idea of the difficulties which Mr. Andrews had to face in making his way over the island. As a matter of fact, with the help which he found available, his rate of progress was not more than two miles a day. The island, moreover, swarms with gigantic land-crabs and rats, which, however interesting from a scientific point of view, are plagues to the explorer. Mr. Andrews had often to sleep out unprotected by a tent, and had to adapt himself as best he could to having his toes nipped by the formidable pincers of the crabs, and his body scampered over by hundreds of rats. The only chance of survival for animals in Christmas Island is their ability to climb trees and swing lianas, and both rats and crabs are as accomplished at this as monkeys in an African forest. Mr. Andrews has brought home ample collections of these and of the other animal life which abounds on the island, the insects being particularly rich. The flora of the island, also, is abundantly represented in Mr. Andrews's collections, as well as geology and other branches of science. To geologists especially the island is of great interest. The core of the island is volcanic, but originally a coral reef occupied the position. The original reef, or atoll, it is believed, now forms the cap or summit of the island, and at intervals downwards coral bands exist, which seem to indicate that the elevation must have been gradual and at considerable intervals. These are among some of the valuable results brought back by Mr. Andrews, and science owes a debt of gratitude to Sir John Murray for his liberal enterprise in equipping the expedition. Mr. Andrews will probably give some account of his work at the Bristol meeting of the British Association, and is expected to read a paper on the subject at the Royal Geographical Society's next session. He has brought home about 400 photographs.

GENERAL.

ALTHOUGH Columbus, Ohio, was chosen as the place of meeting of the American Association in 1899, the invitation from Philadelphia was declined with much regret. It was prepared with great care and presented with much cordiality, and it is to be hoped that Dr. Brinton and other Philadelphia members will renew the invitation next year

THE Council of the American Association authorized last week the appointment of a committee 'to increase the efficiency of the Naval Observatory.' It consists of Professor Picker-

ing, President Mendenhall and Professor Woodward.

HEREAFTER the various Secretaries of the American Association are to be granted $20 for hotel expenses, provided that during the meeting they reside at the headquarters. This seems to be an excellent plan, though it should also be conditional on their being in attendance throughout the meeting beginning on Saturday. The confusion that is likely to occur in the earlier programs is usually due to lack of preliminary meetings of the Secretaries.

THE plan of holding no general sessions daily of the whole Association received a fair test at the Boston meeting. It gave more time to the sections and greatly reduced the amount of more or less wearisome debate which in former years wasted much time.

THE remarks of President Eliot, in his admirable address before the American Association, on the importance of scientific advice to the nation in time of war, was emphasized by the fact that both the Vice-President, Professor Cooley, and the Secretary, Professor Aldrich, of Section D. (Mechanical Science and Engineering) were detained from attendance at the meeting owing to active service in the Navy.

AT the recent meeting of the American Association, Professor E. W. Morley was appointed to succeed the late Professor W. A. Rogers on the Committee on Standards and Measurements.

THE University of Cambridge has conferred the honorary degree of D.Sc. on Professor Henry P. Bowditch, of Harvard University.

PROFESSOR EDWARD S. MORSE has just been decorated by the Emperor of Japan with the Order of the Third Class of the Rising Sun. A letter from the Japanese Minister at Washington translates the diploma accompanying the Order as follows: "His Majesty, the Emperor, has graciously been pleased to confer upon you this Order in recognition of your signal service while you were in the faculty of science in the Imperial University in Tokio, and also in opening in our country the way for zoological, ethnological and anthropological science and in establishing the institutions for the same."

DR. MARK V. SLINGERLAND, of Cornell University, has been appointed State Etomologist of New York in place of the late Dr. J. A. Lintner.

THE proposed session of the New Mexico Biological Station at Albuquerque in August has been given up on account of the prevalence of smallpox in that vicinity.

A SCIENCE CLUB has been formed at Mesilla Park, N. M. Mr. C. M. Barber is President.

THE opening of Queen Victoria's Cottage Grounds at Kew Gardens will be delayed until spring, as there are no funds available this year for the cost of fencing and other necessary work which must first be carried out.

THE young male giraffe from Senegal, which was one of the latest additions to the menagerie of the Zoological Gardens at London, and for which the Society paid £900, has just died.

THE Report of the South African Museum at Cape Town states that the total number of visitors to the Museum during 1897 was 56,723; this, notwithstanding the fact that the Museum was only open for a little more than eight months is 7,313 in excess of the previous year. The monthly average is 6,482, and the daily average 254, the largest number on a single day being 2,993 on June 22d, the lowest, 96, on November 24th.

MR. J. MACKAY BERNARD KIPPENROSS has contributed the sum of £500 in order that the Ben Nevis Observatories may be continued another year. In his letter to the Scottish Meteorological Society, quoted in *Nature*, Mr. Kippenross expresses the hope that before the end of that year arrangements may have been made for the permanent carrying-on of the work by State aid, and his very liberal and prompt action makes the Directors more hopeful than they were that this desirable end may yet be reached. The question of the position of the Ben Nevis Observatories was brought up in the House of Commons on August 5th, in connection with the annual vote of £15,300 to the Meteorological Council for meteorological observations. The Ben Nevis Observatories now receive an annual grant of £350 from this fund. Mr. Hanbury, Financial Secretary to the Treasury, has undertaken to ascertain whether a larger amount could not be voted, the sug-

gestion being made that a grant of £500 a year should be made for five years.

EXPERIMENTS are being undertaken by Professor Lawrence Bruner, of the University of Nebraska, to determine the methods that might be used in spreading among our native species a locust disease discovered by him in South Africa last year. The disease is closely related to the fungus used for destroying chinch bugs in some parts of the United States. Professor Bruner contributes an article on the subject to the July bulletin of the Nebraska Section of the Climate and Crop Service of the Weather Bureau.

THE *British Medical Journal*, quoting from the *Morning Post*, states that two members of the Italian Chamber of Deputies, Signor Leopoldo Franchetti and Signor Fortunato, have issued a circular proposing the foundation of a society for studying the phenomena of malaria. "The malaria," they state, "keeps 2,000,000 hectares (nearly 5,000,000 acres) of ground in Italy from cultivation; it effects, more or less, 63 provinces and 2,823 communes; and every year it poisons about 2,000,000 inhabitants, killing 15,000 of them. It is impossible to estimate the economic damage done to our country by the scourge, and no sanitary problem is more intimately bound up with the question of our prosperity." The authors of the circular, therefore, propose that a society be formed for studying malaria and for discovering the best means of combating it. Those who contribute 500 lire will have the title of founders, and ordinary members will pay 36 lire a year. Signor Franchetti and Signor Fortunato have subscribed 1,000 lire each.

THE first Congress of Legal Medicine will be held at Turin in October, under the presidency of Professor Lombroso.

A METEOROLOGICAL department in connection with the Federal telegraph service has just been established in Mexico.

THE government of British Guiana has lately taken steps of great practical utility in arranging for geological surveys in the gold districts. *Nature*, quoting from a report on the gold and forest industries of British Guiana, states that a survey has already been conducted by Professor J. B. Harrison in the northwest district and the results embodied in a report, while an additional report on the petrology of the district is awaiting publication. A further expedition to examine the formations of the Potaro-Conawarook district is now being organized. The great importance of this work will be recognized in view of the fact that there are no trustworthy official reports on the geology of British Guiana in existence. The experience of the past ten years has proved that British Guiana is rich in gold; and what is now needed is the importation into the colony, and the adoption of, mechanical washing appliances for alluvial gold. By such means deposits of alluvial gold, vast areas of which are known to exist, but would not pay to work by the means now employed, could be made to produce large quantities of gold. During the year ending on June 30th the amount of gold exported from the colony was 117,265 ounces, or a decrease of 10,326 ounces upon the output of 1896-97. This serious decrease is partly ascribed to exceptionally bad weather, and partly to the exhaustion of alluvial workings in the Barima district.

THE N. Y. Fisheries, Game and Forest Commission proposes to purchase about 50,000 acres of land in the Catskills, in addition to the 56,212 acres already owned by the State. The Commission reports that deer are increasing very rapidly in the Catskills. It is estimated that the 44 animals turned loose about a year ago have increased to 150, and that there will be between 400 and 500 of these animals at the expiration of the five year period during which their killing is prohibited.

UNIVERSITY AND EDUCATIONAL NEWS.

THE second cousins of Dr. Elizabeth H. Bates, who died at her home at Port Chester, N. Y., a few months ago, leaving the University of Michigan an estate valued at $125,000, for the establishment of a chair for diseases of women and children, have filed a notice at Ann Arbor that they will contest the will.

AT the New Mexico Agricultural College and Experiment Station, Professor C. H. T. Townsend has been appointed Biogeographer and Systematic Entomologist to the Station; E. O.

Wooten has been appointed professor of botany, and T. D. A. Cockerell has been appointed professor of entomology in addition to being Station Entomologist.

ROBERT B. OWENS, for the past seven years professor of electrical engineering in the University of Nebraska, has resigned in order to accept a similar position in McGill University, Montreal. His successor has not yet been appointed.

T. PROCTOR HALL has been appointed professor of physics in Kansas City University.

DR. BLOCHMAN, professor of zoology in the University of Rostock, has been called to Tübingen as successor to the late Professor Eimer; Dr. Fritsch has been appointed Director of the Botanical Museum of the University of Vienna; Dr. D. K. Morris, lecturer in technical electricity in the Mason University College, Birmingham; Dr. D. Frazer Harris, lecturer in physiology in the University of St. Andrew's. Dr. Kerschner, of the University at Innsbruck, has been promoted to a full professorship of histology; Dr. Reitzenstein, of the University of Mühlhausen, has qualified as docent in chemistry in the University at Würzburg; Dr. Kolkwitz, in botany in the University of Berlin; Dr. Klingenberg, in mechanical engineering, in the Polytechnic Institute of Berlin; Dr. Schröter, in botany, in the University at Bonn, and Dr. Rothmund, in physical chemistry, in the University of Munich.

DISCUSSION AND CORRESPONDENCE.

ON THE OCCURRENCE OF PLACOCEPHALUS (BIPALIUM) KEWENSE IN THE SANDWICH ISLANDS.

Two specimens of land-planarians from the Sandwich Islands were sent to the writer from the National Museum for identification which proved to be the interesting Placocephalus (Bipalium) Kewense. They were taken by Dr. Steiniger in November, 1896, on the island of Oahu, at the top of the Pali, near Honolulu. The specimens were small ones, and in the living condition could not have exceeded 150 mm. in length. If we except New Zealand, this form has been known in the Pacific only from Upolu, one of the Samoan Islands, and its occurrence in the Sandwich Islands is of especial interest in bridging over a large gap in the distribution of so cosmopolitan a form. Doubtless it has also been introduced there, where so much of the vegetation is of foreign origin.*

The writer† has recorded the occurrence of this species in the United States at Cambridge, Mass, and has since received specimens from Baltimore, Md.; Pittsburg and Allegheny, Pa., and Springfield, Ohio, in every case from greenhouses. Outside of the tropics the form has been taken only in plant houses. The writer would be grateful for any specimens or information from the Pacific Coast.

W. McM. WOODWORTH.

MUSEUM OF COMPARATIVE ZOOLOGY,
CAMBRIDGE, MASS., August 15, 1898.

SCIENTIFIC LITERATURE.

La Theorie Platonicienne des sciences. Par ÉLIE HALÉVY. Paris, Félix Alcan.

It is to be feared that Mr. Halévy and his reviewer have gained admission to the pages of SCIENCE under cover of an *équivoque.* The word 'sciences' in Mr. Halévy's title has perhaps a somewhat broader meaning than that it bears in ordinary English usage. It is rather 'knowledge' than 'science.' Mr. Halévy's book is not an account of Plato's supposed contributions to mathematics and astronomy, or a discussion of his casual utterances concerning the inchoate physical sciences of the fourth century B. C. It deals rather with epistemology than with physical science. Its main thesis is that the Platonic philosophy is the result of a dialectical analysis of the epistemological conditions of the sciences—of the 'knowledges,' of the certainty of human knowledge. The arts and sciences exist. What are the logical presuppositions of their existence and of our sense of certainty regarding them? Whatever philosophy of ideas is involved in the very existence of a body of arts and sciences must be a true philosophy. In constructing such a philosophy out of Plato's dramatic dialogues Mr. Halévy displays great ingenuity and power of consecutive logical thought. He over-refines,

* For the distribution of this interesting form see Colin, A. Sitzungsb. Gesell. nature f. Freunde, Berlin, Jahrg., 1892, No. 9, p. 164.

† *American Naturalist*, Vol. XXX., p. 1046, 1896.

over-systematizes, and occasionally strains the meaning of a text. But those who agree with him least will profit by rethinking with such a vigorous and subtle intelligence the entire content of Plato's thought. More specific criticism would involve us in questions of metaphysics or in the philological interpretation of texts. Inste .d of entering upon these details I propose to avail myself of this opportunity to say a word concerning Plato's attitude towards the physical sciences, and the notion, widely prevalent among modern men of science, that, while Aristotle is the 'master of those who know' and the pioneer of science in a prescientific age, Plato is the master of those who dream and the incarnate antithesis of the scientific spirit. If this is an error, a brief statement of its causes may be not without interest. Chief of these is the fact that Plato, despite his high attainments in mathematics, was essentially a literary artist and philosopher, while Aristotle, as Lewes' well-known book shows in detail, was a serious investigator, or at least collector of facts, in the biological sciences, and said one or two very quotable things about the charms of the study of Nature's humblest products.

But the question is not so much of professional occupation as of temper, insight and influence. Now Plato, taking for granted the secondary education in 'music' and gymnastics, demanded that the higher education should be based on a firm foundation of mathematics, astronomy, and mathematical physics; he asked for the endowment of scientific research, and in his *obiter dicta* concerning the imperfect science of his time he displayed marvellous tact in avoiding the colossal errors into which Aristotle was lead by his reliance on verbal definitions and his 'spirit of system.' How is it, then, that the popular judgment sets Plato down as an opponent of science? No better explanation can be found than Bacon's statement that Plato corrupted science by theology, while Aristotle corrupted it by logic. Plato's predominant ethical interest and his dread of a certain hard dogmatic materialism associated with the name of Democritus led him to insist on the antithesis of spirit and matter, and on a teleological view of the world, in language which sentimentalists have employed as a weapon in the supposed 'warfare of religion and science.' Like Emerson, he has borne the burden of the folly of disciples attracted to him solely by a vague sense of the spiritual edification and beauty dimly apprehended in his words. Of course, a teleological view of the world is wholly compatible with science provided the teleology be sufficiently abstract and comprehensive. It is the '*surnaturel particulier*' with which science wars. But just here Plato's literary and poetic genius has done him harm with certain severe but somewhat literal-minded thinkers. For in his *Timæus* he deliberately undertook to make the entire universe, as known to the science of the fourth century B. C., a poetical allegory of spiritual and teleological meanings. The literary beauty of this 'Hymn of the Universe' is a matter of taste—perhaps of acquired taste. But its crude literal acceptance is possible only to a defective historic sense, and leads to the grossest misinterpretations both of Plato and of ancient thought generally. Now, unfortunately, the chief source from which too many men of science derive their impression of Plato's conception of the world is precisely the *Timæus* in the bald, literal and unsympathetic *résumés* given by Grote and Draper. I hope I shall not be accused of wilful paradox when I add that this illustrates one of the chief dangers of an education exclusively in physical science—the excessive reliance on authority.

'Science,' of course, knows no authority, and in the end tests all things. But the individual man of science, unless he undertakes to repeat the entire investigation, must accept the experimental results of his confrères on authority, first satisfying himself, if possible, of the general validity of the method and the good scientific standing of the investigator. This habit of mind he takes with him to the study of historical and philological questions where (I do not speak of the general public) it is much easier to control an investigation by an appeal to the sources, and where consequently (among trained men) secondary authorities count for less. It would be interesting to illustrate this by the abuse formerly of Lewes' 'Biographical History of Philosophy,' and, since Tyndall's Belfast address, of Lange's clever but one-sided 'History of Materialism.' But I have already

abused my usurped license of wandering from my text.

PAUL SHOREY.

UNIVERSITY OF CHICAGO.

The Story of the Atmosphere. By DOUGLAS ARCHIBALD. Published in the Library of Useful Stories. New York, D. Appleton, & Co. 1897. Price, 40 c.

In the 'Story of the Atmosphere,' Mr Archibald has given us an excellent popular account of the most important features of modern deductive meteorology. His success in presenting the subject in such an elementary manner is really remarkable, and is without doubt due to his many years' interest in this branch of the science. Few Englishmen appear to have been greatly attracted by the deductive treatment of meteorology, and those who have shown by their writings that they have been pursuing this line of study have been most strongly represented by the Indian meteorologists, and foremost and earliest among these must be placed Blanford; and no Englishman has followed his lead more closely than Mr. Archibald, whose writings have received well merited attention during the past fifteen or twenty years.

It is, then, with the knowledge that Mr. Archibald is thoroughly familiar with his subject that we enter upon the perusal of his book; and, as we finish it, we must admit it to be an important and very satisfactory addition to our popular science literature.

Mr. Archibald has shown great skill in selecting the material that he presents to the reader, and he has given it in a very interesting manner. It is, however, more of a student's book than might appear at first sight. It is just the book for a well educated man or woman to take up and read as supplementary to studies formerly pursued in schools, and in the hands of a teacher of meteorology or physical geography it will prove a valuable addition to the elementary text-books on those sciences.

Mr. Archibald's remarks on the origin and height, nature and composition, pressure and weight, of the atmosphere are clear and interesting; but the chief value of the book, in the eyes of a specialist, lies in the chapters on the temperature and motions of the atmospheric air. In these the author gives the reader the full benefit of his study of meteorological literature of various lands during the last score of years; during which time dynamical meteorology has made remarkable advances as a science, owing to the labor of various eminent physicists who have devoted considerable attention to it. In this portion of the book Ferrel's work has been given the prominence which it deserves, and the subjects presented have probably never been given in a clearer manner. It is interesting to note that the author has wisely reproduced some of Ferrel's original diagrams which have historic value.

Probably the most interesting chapter to the average reader is the one on 'Suspension and Flight in the Atmosphere.' This gives a succinct account of aërial navigation of all kinds—bird flights, ballooning, kite flying, air ships, etc. The various problems pertaining to these are elucidated and commented on with great discrimination. The last chapter deals very briefly but suggestively with 'Climate and Life in the Atmosphere.'

FRANK WALDO.

GREAT SMOKY MOUNTAINS, N. C.

NEW BOOKS.

Researches in the Uloa Valley, Honduras; Caverns of Copan. GEORGE BYRON GORDON. Cambridge, published by the Peabody Museum. 1898. Pp. 44 and 12 Plates.

Catalogue of Scientific Periodicals, 1865–1895. H. CARRINGTON BOLTON. Second Edition, 1897. Washington, Smithsonian Institution. 1898. Pp. vii+1247.

Forestry Conditions in Northern Wisconsin. FILIBERT ROTH. Madison, Published by the State. 1898. Pp. vi+78.

Instincts and Habits of the Solitary Wasps. GEORGE W. PECKHAM and ELIZABETH G. PECKHAM. Madison. 1898. Pp. iv+245 and 14 Plates.

Symons' British Rainfall, 1897. G. J. SYMONS and H. SOWERBY WALLACE. London, Stanford. 1898. Pp. 239.

Calcul des conduites d'eau. G. DARIES. Paris, Gauthier-Villars et fils. 1898. Pp. 194.